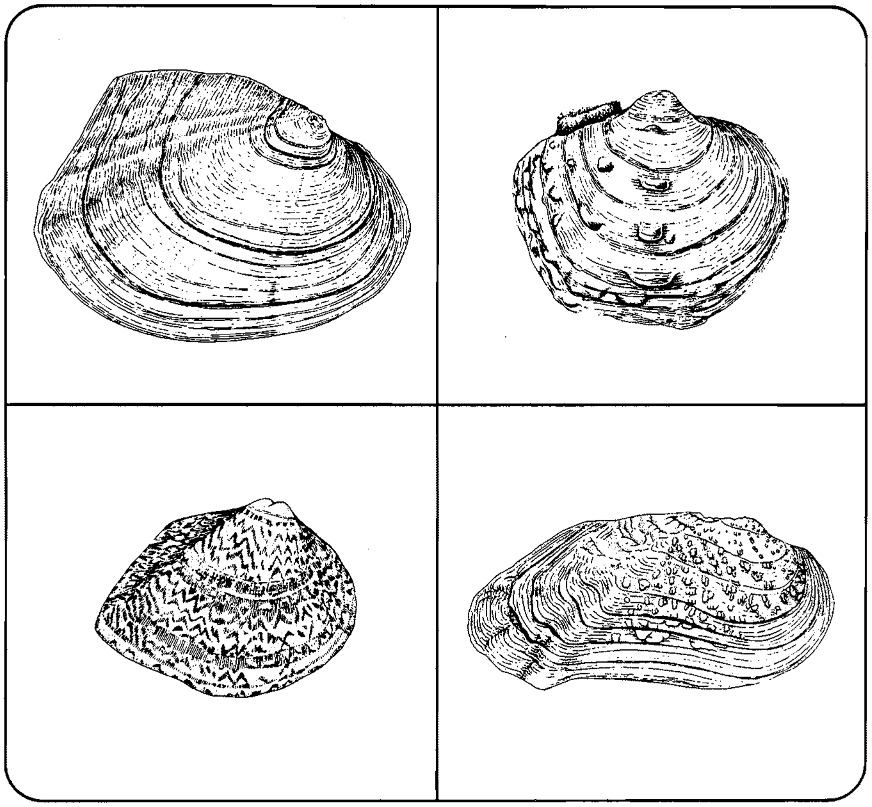
An Illustrated Key to the Freshwater Mussels (Bivalvia: Unionacea) of Wisconsin

Edward M. Stern



REPORTS of the
Museum of Natural History
University of Wisconsin-Stevens Point

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Edward M. Stern

Illustrated By Julie Janke

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Cover Illustrations

Lasmigona complanata	*Quadrula nodulata*
Truncilla truncata	*Tritogonia verrucosa*

Publication Note

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Introduction

North America contains the richest freshwater molluscan (clams and snails) fauna in the world, with a large percentage of the species occurring throughout the vast Mississippi River system. The freshwater bivalve fauna of Wisconsin includes five families, three of which are native (Sphaeriidae, Margaritiferidae, and Unionidae). The family Corbiculidae represents an asiatic introduction and the family Dreissenidae was introduced from Europe. Of the five families, the Unionidae is the most diverse, with approximately 50 species. It is also the most thoroughly studied and the most recently surveyed.

While this manual is intended to be used primarily for the identification of freshwater mussels, some general comments are appropriate. Detailed discussions concerning distribution (throughout North America as well as statewide), biology, and "normal" and pollution ecology can be found in Baker (1928), Fuller (1974), Burch (1975), Mathiak (1979), and Thiel (1981).

The Wisconsin unionid fauna originated in the Interior Basin and has its greatest affinity with the Mississippi River fauna. The surface waters of the State belong to one of two major drainage basins, the Mississippi and the St. Lawrence (Lakes Superior and Michigan). The greatest species diversity and abundance occur in the Mississippi River tributaries that drain the State. There have been temporary connections between the Mississippi River and St. Lawrence basin, the best known having involved the Lake Michigan basin between the Wisconsin and Fox rivers at Portage in Columbia County. Despite these intermittent confluences, the fauna of the St. Lawrence basin (and especially the Lake Superior basin) is a depauperate fauna. Figure 1 illustrates the major drainages in the State.

Unionid bivalves are important members of the freshwater community for a number of reasons. Historically the soft tissues were used for food and the shells were used for tools and cooking utensils as well as a source of mother-of-pearl for the button industry. Today, while the presence of heavy metals and other contaminants in the tissues prevents their use as food by man, the value of mussels is more important and more varied than ever. Ground-up shell fragments from several Wisconsin species are used as nuclei in the growth of cultured pearls. More recently the value of freshwater mussels as biological indicator organisms, in both natural and polluted waters, has been recognized.

Unionids exhibit a variety of symbiotic relationships with a number of other aquatic invertebrates and vertebrates, including flukes, leeches, water mites, and mammals. Of all of these associations, none is more important than the relationship between unionid mussels and fishes. As a normal part of their life cycle (Fig. 2), unionid larvae (called glochidia) become parasites on the body of a host fish. It is during this period that mussels are distributed from one site to another.

Ecologically, adult unionids inhabit a variety of substrates. The greatest species diversity exists in riverine habitats and the majority of species occur in a substrate with a mixture of particle sizes ranging from silt to boulder. A major exception is the genus *Anodonta*, several species of which are frequently most abundant in impounded habitats.

Despite the continued commercial value of unionids and the recognition of their importance in freshwater ecosystems, one of the major problems involves the identification of the species. While there are several identification manuals available, many rely on features of the soft anatomy of gravid females (i.e. females that contain developing eggs and/or larvae). Much of the material routinely collected consists only of empty shells. It is difficult at many sites to collect live specimens and impossible to collect gravid females at certain times during the year because of limited and variable breeding seasons. Recognizing these difficulties, this key relies only on shell characteristics so as to be useful to the non-specialist. By its nature, then, this key is artificial and several assumptions have been made so that it is not overly cumbersome.

The key includes members of the families Margaritiferidae and Unionidae, down to the level of species, that have been reported in Wisconsin waters. Table 1 contains a complete list of species, identifying those believed to be extirpated and/or of doubtful occurrance. The key is based on shell characters of adult individuals (juvenile shells frequently differ in color, shape, and sculpturing) and constructed to include both males and females among those species that exhibit sexual dimorphism. No attempt was made to include the complete range of conchological variation (recognizing that most of the species occur throughout the entire Mississippi River system), a problem clearly evident in several of the species complexes in the genera *Lampsilis* and *Pleurobema*.

It is advantageous to use fresh material and even then it may be necessary to scrub the periostracum to reveal shell color and expose sculpturing and rays, if present. It is also desirable to have a small series to work with, when practical, rather than a single shell, to better illustrate local variability and because there is almost always some natural shell deterioration or wear.

The key is designed with a pair of alternative or contrasting statements in each couplet. Following the selection of the choice that most closely agrees with the specimen, the reader is then directed to the next couplet and eventually to the correct species identification. If the final description and species illustration do not agree with the specimen at hand, it is necessary to back-track. General external and internal morphological features of the shell are illustrated in Figures 3-5 and the terminology is defined in the accompanying Glossary. The external view of the right valve and the internal view of the hinge line of the left valve are illustrated for each species. Scale lines = 1 cm.

TABLE 1. Wisconsin bivalves. Species arranged alphabetically under each subfamily. Common names follow the AMU (American Malacological Union) standardized list (Turgeon et al., 1988). Numbers under NOTE refer to comments under corresponding section at end of text.

	COMMON NAME	NOTE	FIGURE
Family Corbiculidae			
Corbicula fluminea (Muller, 1774)	Asiatic clam	1	6
Family Dreissenidae			
Dreissena polymorpha (Pallas, 1771)	Zebra mussel	2	7
Family Sphaeriidae			
Sphaerium, *Pisidium*	Fingernail, pill clams	3	8
Family Margaritiferidae			
Cumberlandia monodonta (Say, 1829)	Spectacle case		9
Family Unionidae			
Subfamily Unioninae			
Amblema plicata (Say, 1817)	Three-ridge	4	10
Cyclonaias tuberculata (Raf., 1820)	Purple wartyback		11
Elliptio complanata (Lightfoot, 1786)	Eastern elliptio		12
E. crassidens (Lamarck, 1819)	Elephant ear	5	13
E. dilatata (Raf., 1820)	Spike		14
Fusconaia ebena (Lea, 1831)	Ebony shell		15
F. flava (Raf., 1820)	Wabash pigtoe	6	16
Megalonaias nervosa (Raf., 1820)	Washboard	7	17
Plethobasus cyphyus (Raf., 1820)	Sheepnose		18

Table 1 (Continued).

	COMMON NAME	NOTE	FIGURE
Pleurobema cordatum (Raf., 1820)	Ohio pigtoe	8	19
Quadrula metanevra (Raf., 1820)	Monkey face		20
Q. nodulata (Raf., 1820)	Wartyback		21
Q. pustulosa (Lea, 1831)	Pimpleback		22
Q. quadrula (Raf., 1820)	Mapleleaf	9	23
Tritogonia verrucosa (Raf., 1820)	Pistolgrip		24
Subfamily Anodontinae			
Alasmidonta marginata Say, 1818	Elktoe		25
A. viridis (Raf., 1820)	Slippershell	10	26
Anodonta cataracta Say, 1817	Eastern floater		27
A. grandis Say, 1829	Giant floater	11	28
A. imbecillis Say, 1829	Paper pondshell		29
A. suborbiculata Say, 1831	Flat floater		30
Anodontoides ferussacianus (Lea, 1834)	Cylindrical papershell		31
Arcidens confragosus (Say, 1829)	Rock pocketbook		32
Lasmigona complanata (Barnes, 1823)	White heelsplitter		33
L. compressa (Lea, 1829)	Creek heelsplitter		34
L. costata (Raf., 1820)	Fluted shell		35
Simpsonaias ambigua (Say, 1825)	Salamander mussel	12	36
Strophitus undulatus (Say, 1817)	Squawfoot		37

Table 1 (Continued).

	COMMON NAME	NOTE	FIGURE
Subfamily Lampsilinae			
Actinonaias ligamentina (Lamarck, 1819)	Mucket	13	38
Ellipsaria lineolata (Raf., 1820)	Butterfly	14	39
Epioblasma triquetra (Raf., 1820)	Snuffbox	15	40
Lampsilis higginsi (Lea, 1857)	Higgins eye	16	41
L. ovata (Say, 1817)	Pocketbook	17	42
L. radiata (Gmelin, 1791)	Eastern lampmussel	18	43
L. teres (Raf., 1820)	Yellow sandshell	19	44
Leptodea fragilis (Raf., 1820)	Fragile papershell		45
L. leptodon (Raf., 1820)	Scaleshell	20	46
Ligumia recta (Lamarck, 1819)	Black sandshell		47
Obliquaria reflexa Raf., 1820	Threehorn wartyback		48
Obovaria olivaria (Raf., 1820)	Hickorynut		49
Potamilus alatus (Say, 1817)	Pink heelsplitter	21	50
P. capax (Green, 1832)	Fat pocketbook	22	51
P. ohiensis (Raf., 1820)	Pink papershell	23	52
Toxolasma parvus (Barnes, 1823)	Lilliput	24	53
Truncilla donaciformis (Lea, 1828)	Fawnsfoot		54
T. truncata Raf., 1820	Deertoe		55
Venustaconcha ellipsiformis (Conrad, 1836)	Ellipse	25	56
Villosa iris (Lea, 1829)	Rainbow		57

NOTES

Unionid mussel classification for the higher taxa is not universally standardized. Numerous schemes have been suggested (recognizing a variety of families and subfamilies) based upon different interpretations of shell features, soft anatomy, and reproductive biology. Although the common names have been standardized (Turgeon et al., 1988), the validity of several species is still under discussion. This manual takes a more conservative approach and, where appropriate, the more commonly used synonyms have been included.

1 -- *Corbicula* is an asiatic introduction that now occurs virtually throughout North America having first been reported in 1938 in the Columbia River. *Corbicula fluminea* (=*C. manilensis* of some authors) is considered to be a pest species and a threat to the native fauna.

2 -- *Dreissena polymorpha*, a species native to Europe, was introduced into the Great Lakes in the mid 1980's. Its rapid spread suggests that this serious pest species has the potential to invade much of North America.

3 -- Some authors recognize the genus *Musculium* while others consider those species to be ecological variants within the genus *Sphaerium*.

4 -- *Amblema = Crenodonta.*

5 -- With few recent records, the distribution of *Elliptio crassidens* in the upper Mississippi River is unclear.

6 -- *Fusconaia undata* is treated as an ecological form of the widespread, highly variable *F. flava.*

7 -- *Megalonaias nervosa = M. gigantea.*

8 -- *Pleurobema cordatum = P. coccineum = P. sintoxia = P. rubrum* of some authors. A widespread, highly variable species.

9 -- *Quadrula quadrula = Q. fragosa.*

10 -- *Alasmidonta viridis = A. calceolus.*

11 -- *Anodonta grandis = A. corpulenta.* A widespread, highly variable species with many recognized subspecies.

12 -- *Simpsonaias = Simpsoniconcha.*

13 -- *Actinonaias ligamentina = A. carinata.*

14 -- *Ellipsaria lineolata = Plagiola lineolata.*

15 -- *Epioblasma triquetra = Dysnomia triquetra.*

16 -- *Lampsilis higginsi* is a federally endangered species and is restricted to the lower Wisconsin, St. Croix, and upper Mississippi Rivers.

17 -- *Lampsilis ovata* = *L. ventricosa.*

18 -- *Lampsilis radiata* = *L. siliquoidea* = *L. luteola.* A widespread, highly variable species with many recognized subspecies.

19 -- *Lampsilis teres* = *L. anodontoides.* Some authors recognize two species while others recognize two forms, *L. t. teres* with light green rays over a portion of the shell and *L. t. anodontoides*, the rayless subspecies.

20 -- No living individuals of *Leptodea leptodon* have been collected in Wisconsin waters since Baker (1928) reported it from the Mississippi River near McGregor, Iowa.

21 -- *Potamilus* = *Proptera.*

22 -- *Potamilus capax* is a federally endangered species and apparently has been extirpated from the upper Mississippi River.

23 -- *Potamilus ohiensis* = *P. laevissima.*

24 -- *Toxolasma* = *Carunculina.*

25 -- *Venustaconcha ellipsiformis* = *Actinonaias ellipsiformis.*

Key to Species

1 Hinge ligament internal; hinge teeth absent or with vestigial posterior lateral tooth; shell color yellow or brown with zig-zag brown and yellow bands. ....**Family Dreissenidae,** *Dreissena polymorpha* (Fig.7)

Hinge ligament external 2

2(1) Anterior and posterior lateral teeth always present on both sides of cardinal tooth (Fig. 5-G); adults small, usually less than 1 1/2 inches in length 3

Lateral teeth, if present, always posterior to pseudocardinal teeth (Fig. 3-B), with poorly developed pseudocardinal and/or posterior lateral teeth, or hinge teeth absent entirely; adults large, usually more than 1 1/2 inches in length **(Families Margaritiferidae and Unionidae)** 4

3(2) Shell heavy; concentric growth rings pronounced. .... **Family Corbiculidae,** *Corbicula fluminea* (Fig. 6)

Shell thin and fragile; concentric growth rings not as pronounced. ....**Family Sphaeriidae,** *Pisidium* and *Sphaerium* (pill and fingernail clams) (Fig. 8)

4(2) Hinge teeth (pseudocardinals and laterals) reduced or absent entirely.........5

Hinge teeth prominent, well developed..........18

5(4) Pseudocardinal and lateral teeth absent entirely 6

Pseudocardinal and/or lateral teeth poorly developed or one absent entirely..........10

6(5) Umbo flattened and not extending above hinge line..........7

Umbo moderately to greatly elevated above hinge line..........8

7(6) Shell nearly round in outline..........*Anodonta suborbiculata* (Fig. 30)

Shell elongate..........*Anodonta imbecillis* (Fig. 29)

8(6) Beak sculpture consists of 3-4 sharp concentric ridges, turned up sharply posteriorly..........*Anodontoides ferussacianus* (Fig. 31)

Beak sculpture with double-looped ridges 9

9(8) Beak sculpture double-looped and with nodules or tubercules.......... *Anodonta grandis* (Fig. 28)

Beak sculpture double-looped without nodules .... *Anodonta cataracta* (Fig. 27)

10(5) Shell surface with ridges, undulations or nodules, especially on posterior slope 11

Shell surface smooth, without undulations or nodules 13

11(10) Ridges located on posterior 1/2 of shell, which give rise to 2 rows of irregular knobs that continue onto the umbo .... *Arcidens confragosus* (Fig. 32)

Radiating ridges confined to posterior slope on shell 12

12(11) Posterior ridge low, rounded; undulations on posterior slope; periostracum brown, rays poorly defined .... *Lasmigona costata* (Fig. 35)

Posterior ridge prominent, sharply angled; undulations on posterior slope; periostracum yellowish-brown with numerous broad green rays .... *Alasmidonta marginata* (Fig. 25)

13(10) Shell greatly compressed, with well developed alae .... *Lasmigona complanata* (Fig. 33)

Shell moderately to well inflated, without alae 14

14(13) Hinge with elevated, triangular pseudocardinal tooth in right valve, smaller, less distinct pseudocardinal tooth in left valve; lateral teeth represented by thickened areas .... *Alasmidonta viridis* (Fig. 26)

Hinge with pseudocardinal teeth represented by small tubercular swellings; lateral teeth also reduced to tubercular swellings or absent entirely 15

15(14) Shell elongated, length twice to three times shell height; periostracum dark brown to black; left valve with single, small pseudocardinal tooth, single, low lateral tooth .... *Cumberlandia monodonta* (Fig. 9)

Shell oval, elliptical, length/height ratio clearly less than 2:1 16

16(15) Shell small, length less than 1 1/2 inches; single, compressed pseudocardinal in each valve, laterals absent .... *Simpsonaias ambigua* (Fig. 36)

Shell length greater than 1 1/2 inches 17

17(16) Nacre purple or salmon colored; beak cavity very shallow; beak sculpture consists of several fine, double-looped ridges .... *Leptodea leptodon* (Fig. 46)

Nacre white, often cream or salmon colored near beak cavity; beak cavity moderately deep; beak sculpture consists of several coarse, double-looped ridges; pseudocardinals reduced to small thickening in both valves, laterals absent .... *Strophitus undulatus* (Fig. 37)

18(4) Shell alate, compressed, usually thin and fragile 19

Shell lacks alae, compressed, moderately or greatly inflated, thin to solid 21

19(18) Pseudocardinal teeth thick, triangular, ragged; nacre pink to purple .... *Potamilus alatus* (Fig. 50)

Pseudocardinal teeth thin, blade-like; nacre white or pink to purple 20

20(19) Shell alate anterior and posterior to umbo; nacre pink to purple; periostracum olive green to dark brown .... *Potamilus ohienis* (Fig. 52)

Shell alate posterior to umbo only; nacre silvery-white; periostracum yellow to yellowish-brown; left valve with two thin, low pseudocardinals, the posterior one often absent .... *Leptodea fragilis* (Fig. 45)

21(18) Shell surface covered with pustules, knobs, and/or ridges 22

Shell surface smooth, interrupted only by natural growth lines 31

22(21) Shell surface with several large rounded undulations or zigzag ridges, lacking pustules and knobs 23

Shell surface with several to many pustules and/or knobs, lacking prominent ridges 24

23(22) Shell sculpture consisting of series of undulations and zigzag (W-shaped) ridges that extend anterior to umbo .... *Megalonaias nervosa* (Fig. 17)

Shell sculpture consisting only of large parallel undulations that do not extend anterior to umbo .... *Amblema plicata* (Fig. 10)

24(22) Shell length clearly greater than height with length/height ratio greater than 1.3; shell elongate-ovate or elongate-rhomboid (Figs. 4-A,E,F) 25

Shell length roughly equal to height with length/height ratio less than 1.3; shell quadrate or round (Figs. 4-C,G) 26

25(24) Shell elongate, posterior end sharply pointed; single row of knobs on center of valve from ventral margin to umbo; left valve with two large, triangular pseudocardinal teeth, two long slightly curved lateral teeth .... *Plethobasus cyphyus* (Fig. 18)

Shell elongate, rhomboid with strong irregular posterior ridge; shell with pustules extending over most of surface .... *Tritogonia verrucosa* (Fig. 24)

26(24) Shell with a few to many pustules or knobs arranged in one or two rows along center of shell and/or on posterior ridge from ventral margin to umbo 27

Shell with many pustules or knobs randomly arranged on lateral and posterior surfaces 29

27(26) Shell with 2-4 large knobs arranged in a single vertical row on center of valve; knobs on one valve alternate with those on opposite valve .... *Obliquaria reflexa* (Fig. 48)

Shell with pustules and knobs arranged in two rows.......................................28

28(27) A sulcus, or depression, present in front of the posterior ridge separating the two rows of pustules; pustules on one valve not opposite those on opposing valve.. *Quadrula quadrula* (Fig. 23)

No sulcus present, side of shell evenly rounded (convex); knobs on one valve more or less opposite those on opposing valve............................... .... *Quadrula nodulata* (Fig. 21)

29(26) Posterior ridge high, angular with sinus (=sulcus) above it; row of large knobs along posterior ridge, smaller pustules anterior and posterior to it.. *Quadrula metanevra* (Fig. 20)

Posterior ridge low, rounded; few to many pustules on surface of shell.......30

30(29) Nacre white... *Quadrula pustulosa* (Fig. 22)

Nacre purple.. *Cyclonaias tuberculata* (Fig. 11)

31(21) Periostracum of adult shell light brown to black; rays, if present, obscure...... 32

Periostracum of adult shell yellow, yellowish-green, or yellowish-brown; rays, if present distinct 39

32(31) Interdentum absent; pseudocardinal teeth distinct, but not enlarged or massive 33

Interdentum present, narrow to broad and flat; pseudocardinal teeth distinct, massive 35

33(32) Adult shell less than 2 inches in length................. *Toxolasma parvus* (Fig. 53)

Adult shell greater than 2 inches in length...34

34(33) Shell very elongate, posterior end bluntly pointed; left valve with two high, roughened pseudocardinals, two long laterals....*Ligumia recta* (Fig. 47)

Posterior end of shell uniformly rhomboidal;.... *Elliptio complanata* (Fig. 12)

35(32) Umbonal cavity shallow, barely extending under interdentum; nacre usually purple..36

Umbonal cavity deep, extending under interdentum; nacre white, sometimes tinted with salmon..37

36(35) Interdentum broad; shell rhomboid; nacre purple...*Elliptio crassidens* (Fig. 13)

Interdentum narrow; shell elongate, nearly twice as long as high; nacre purple, occasionally white..................................*Elliptio dilatata* (Fig. 14)

37(35) Shell nearly circular in outline; umbo well developed, elevated, located well forward of center of shell, apex pointed anteriorly...*Fusconaia ebena* (Fig. 15)

Shell shape nearly triangular; umbo well developed, elevated, located near center of shell, apex not directed anteriorly..38

38(37) Shell with more or less distinct sulcus in front of posterior ridge; posterior margin of shell truncated.................................*Fusconaia flava* (Fig. 16)

Shell without sulcus in front of posterior ridge; posterior margin of shell rounded; left valve with two large, roughened pseudocardinal teeth, two straight, moderately short lateral teeth...*Pleurobema cordatum* (Fig. 19)

39(31) Rays present, distinct, broken into patterns resembling spots, squares, triangles, or zigzags...40

Rays, if present, continuous from umbo to ventral margin............................44

40(39) Shell elongate, elliptical; posterior ridge rounded; green rays most dense on posterior 2/3 of shell..*Villosa iris* (Fig. 57)

Shell rhomboidal to triangular; posterior ridge angular..................................41

41(40) Interdentum wide, flat; green rays broken into squarish bands..*Ellipsaria lineolata* (Fig. 39)

Interdentium narrow or absent; green rays broken into spots, bars, or irregular "w" or zigzag pattern..42

42(41) Green rays broken into squarish, triangular, or chevron-shaped spots; umbonal cavity deep; sexual dimorphism conspicuous, females with pronounced marsupial swelling................*Epioblasma triquetra* (Fig. 40)

Green rays broken into irregular "w" or zigzag pattern; umbonal cavity shallow...43

43(42) Posterior ridge sharply angled, distinct to ventral shell margin; interdentum narrow.. *Truncilla truncata* (Fig. 55)

Posterior ridge moderately angled, becomes rounded near ventral margin; interdentum absent................................ *Truncilla donaciformis* (Fig. 54)

44(39) Umbonal cavity shallow..45

Umbonal cavity moderately to very deep, extends noticeably under hinge line..47

45(44) Umbo elevated well above hinge line, located near and directed toward anterior end; shell inflated, thick, heavy....... *Obovaria olivaria* (Fig. 49)

Umbo slightly elevated above hinge line, more centrally located; shell compressed, solid but thin...46

46(45) Pseudocardinal teeth triangular, rough; nacre bluish-white; beak sculpture consists of faint, double-looped ridges...
.... *Venustaconcha ellipsiformis* (Fig. 56)

Pseudocardinal teeth elongate, thin; nacre white, usually tinged with creme or salmon near beak cavity; beak sculpture consists of several conspicuous, double-looped bars........... *Lasmigona compressa* (Fig. 34)

47(44) Shell elongate, length/height ratio 1.6 or greater..48

Shell higher, length/height ratio less than 1.6 50

48(47) Posterior end and ventral margin broadly rounded; rays, if present, broad and green; left valve with two erect, striated pseudocardinal teeth, two short lateral teeth.................................*Actinonaias ligamentina* (Fig. 38)

Posterior end distinctly pointed or obliquely truncated with blunt point; dorsal and ventral margins straight, nearly parallel; rays, if present, narrow and green..49

49(48) Posterior ridge high, terminates in sharp point high on posterior margin of shell; periostracum yellow, glossy; length/height ratio greater than 2.0; left valve with two compressed pseudocardinal teeth, two long laterals... *Lampsilis teres* (Fig. 44)

Posterior ridge lower on shell, terminates near middle of posterior margin; periostracum yellowish-brown, dull; length/height ratio less than 2.0; left valve with two compressed, pseudocardinal teeth, two short laterals... *Lampsilis radiata* (Fig. 43)

50(47) Pseudocardinals thin, compressed, parallel with hinge line; hinge line with distinct "s" shaped curve; shell thin.................. *Potamilus capax* (Fig. 51)

Pseudocardinal teeth triangular; hinge line gently curved; shell thick, solid... 51

51(50) Left valve with two triangular, erect, divergent pseudocardinal teeth, two short, slightly curved lateral teeth; anterior end broadly rounded; posterior ridge rounded, but distinct; beak sculpture consists of several fine, double-looped ridges................. *Lampsilis higginsi* (Fig. 41)

Left valve with two triangular, low pseudocardinal teeth, two straight lateral teeth; anterior end sharply rounded; posterior ridge rounded; beak sculpture consists of several coarse, double-looped ridges....................... .... *Lampsilis ovata* (Fig. 42)

GLOSSARY

ADDUCTOR MUSCLE SCAR. -- Largest of the nacreous impressions on interior of shell, forming the attachment of the muscles that close the valves (Fig. 3-B).

ALATE. -- Having wings (alae) or winglike projections of the two valves that extend dorsally above the hinge line; usually found as an extension of the posterior slope, but can occur anteriorly.

ANGULAR. -- Having an angle in contrast to being rounded.

BEAK. -- That raised portion along the dorsal margin of each valve; also called the umbo; may be elevated (raised) or depressed (not extending above the hinge line) (Fig. 3).

BEAK CAVITY. -- That cavity formed from the dorsal extension of the beak; may be deep or may be represented only by a shallow depression (Fig. 3-B).

CARDINAL TEETH. -- Elevations on the hinge plate of one valve that interlock with corresponding elevations/ depressions on the opposing valve; typically with lateral teeth situated both anteriorly and posteriorly; (Fig. 5-G); not found in unionids, which have pseudocardinal teeth.

COMPRESSED. -- Flattened laterally as opposed to inflated or obese.

CONCENTRIC. -- Having the same center and expanding outward as in the growth lines of a mussel shell.

CONCHOLOGY. -- The study of molluscs (clams and snails) based upon features associated with the shell.

DENTATE. -- Having hinge teeth present.

DOUBLE-LOOPED. -- In the form of two adjacent semicircles, end to end, with the openings oriented in the same direction (Fig. 5-B).

EDENTULOUS. -- Lacking both lateral and pseudocardinal teeth on the hinge line.

ELLIPTICAL. -- In the form of an ellipse, as in the outline of some unionids (Fig. 4-D).

ELONGATE. -- Decidedly longer than high; lengthened.

EPIDERMIS. -- The proteinaceous outer layer of the shell (=periostracum).

HINGE LIGAMENT. -- The elongate, elastic structure that unites the two shells above the hinge line (Fig. 3).

HINGE PLATE. -- The dorsal portion of the shell bearing the lateral and pseudocardinal teeth.

INFLATED. -- Swollen; expanded; obese; can refer to the condition of the beaks or to the shell width.

INTERDENTUM. -- That surface on the hinge plate between the lateral and pseudocardinal teeth (Fig. 3-B).

KNOB. -- A surface protuberance which is large in size and few in number in contrast to a pustule (Fig. 3-A).

LAMELLA. -- A thin blade as in the shape of most lateral teeth.

LATERAL TEETH. -- The elongate lamellae on the posterior half of the hinge plate (Fig. 3-B).

MALACOLOGY. -- The study of molluscs (clams and snails) based upon soft anatomy.

MARUSPIAL SWELLING. -- The enlarged or inflated ventroposterior portion of the shell of the female unionid; formed during shell growth by the depostion of new shell material around the swollen gravid gills.

MEDIAN SULCUS. -- A dorsoventrally oriented depression (running top to bottom) of the shell from the region of the beaks toward or to the ventral margin (Fig. 3-A).

NACRE. -- The inner layer of a unionid shell composed of calcium carbonate; often glossy and/or colored.

NAIAD. -- The common name used for freshwater mussels of the Superfamily Unionacea.

NODULE. -- See KNOB.

OBESE. -- Swollen; inflated in width.

OBLIQUE. -- Slanting, as in the posterior margin of some unionid shells.

OVAL. -- Oblong, with one end narrower than the other, as in the outline of some unionids (Figs. 4-E,F).

PERIOSTRACUM. -- The thin outer, non-living proteinaceous layer covering the unionid shell.

PLICATIONS. -- More or less parallel ridges or waves on the shell of a unionid; undulations; folds.

POSTERIOR RIDGE. -- A ridge on the shell of many unionids that extends from the umbo posteroventrally toward or to the shell margin (Fig. 3-A).

POSTERIOR SLOPE. -- That area of a mussel shell between the posterior ridge and the dorsoposterior margin (Fig. 3-A).

PSEUDOCARDINAL TEETH. -- The lamellae or teeth on the anterior half of the hinge plate, usually triangular and compact, although not always so (Fig. 3-B).

PUSTULE. -- Small, usually numerous prominences on the surface of a unionid shell (Fig. 3-A).

QUADRATE. -- Square, or approximately so, as in the outline of some unionids (Fig. 4-C).

RAY. -- A linear mark typical on the periostracum of some unionids; may be continuous or interrupted.

RHOMBOIDAL. -- Having the shape of a rhomboid, as in the outline of some unionid shells (Fig. 4-A).

RIDGES. -- Raised areas on the surface of a shell, may be parallel or radiate out from a common center; undulations.

ROUNDED. -- Having a more or less evenly curved contour, as in the outline of some unionids (Fig. 4-G); or in contrast to being angular.

RUDIMENTARY. -- Small, imperfectly developed, as in the hinge teeth of some unionids.

SCULPTURE. -- The natural markings found on the surface of many freshwater mussels; includes knobs, pustules, undulations, etc.

SEXUALLY DIMORPHIC. -- Morphological differences between the males and females of the same species; in unionid mussels this is usually indicated by marsupial swelling found in the female (see MARSUPIAL SWELLING) (Figs. 5-C,D; 41).

SHELL DIMENSIONS. -- (See Figs. 5-E,F).

Length -- Greatest horizontal dimension.

Height -- Greatest vertical dimension measured at a right angle to the length exclusive of the umbo and alae.

Width -- Greatest lateral dimension measured with both valves closed.

SINGLE-LOOPED. -- In the form of one loop or semicircle, as in the sculpture of the umbo in some unionids (Fig. 5-A).

SULCUS. -- A furrow, channel or depression (Fig. 3-A).

TEETH. -- The elevations and/or depressions on the hinge line of one valve that interlock with the corresponding structures on the opposing valve; in the Unionacea the anterior articulating surfaces are the pseudocardinal teeth and the posterior ones the lateral teeth (Fig. 3-B).

TRIANGULAR. -- In the form of a triangle, as in the outline of some unionids (Fig. 4-B).

TRUNCATE. -- Having the end cut off more or less squarely, as in the posterior margin of many unionids.

TUBERCULE. -- See KNOB.

UMBO. -- The oldest portion of the bivalve shell and around which the latter shell is subsequently laid down in a concentric manner; the raised portion on the dorsal margin of the shell; also called beak (Fig. 3).

UMBONAL CAVITY. -- See BEAK CAVITY.

UNDULATION. -- A ridge or wave like feature on the shell of some unionids ; plications.

UNIONACEA. -- The superfamily of bivalve mollusks to which most freshwater mussels belong.

VALVE. -- Either the right or left half of a clam shell.

WING. -- A thin, flat projection extending dorsally from the posterior slope of some freshwater mussels; see ALATE.

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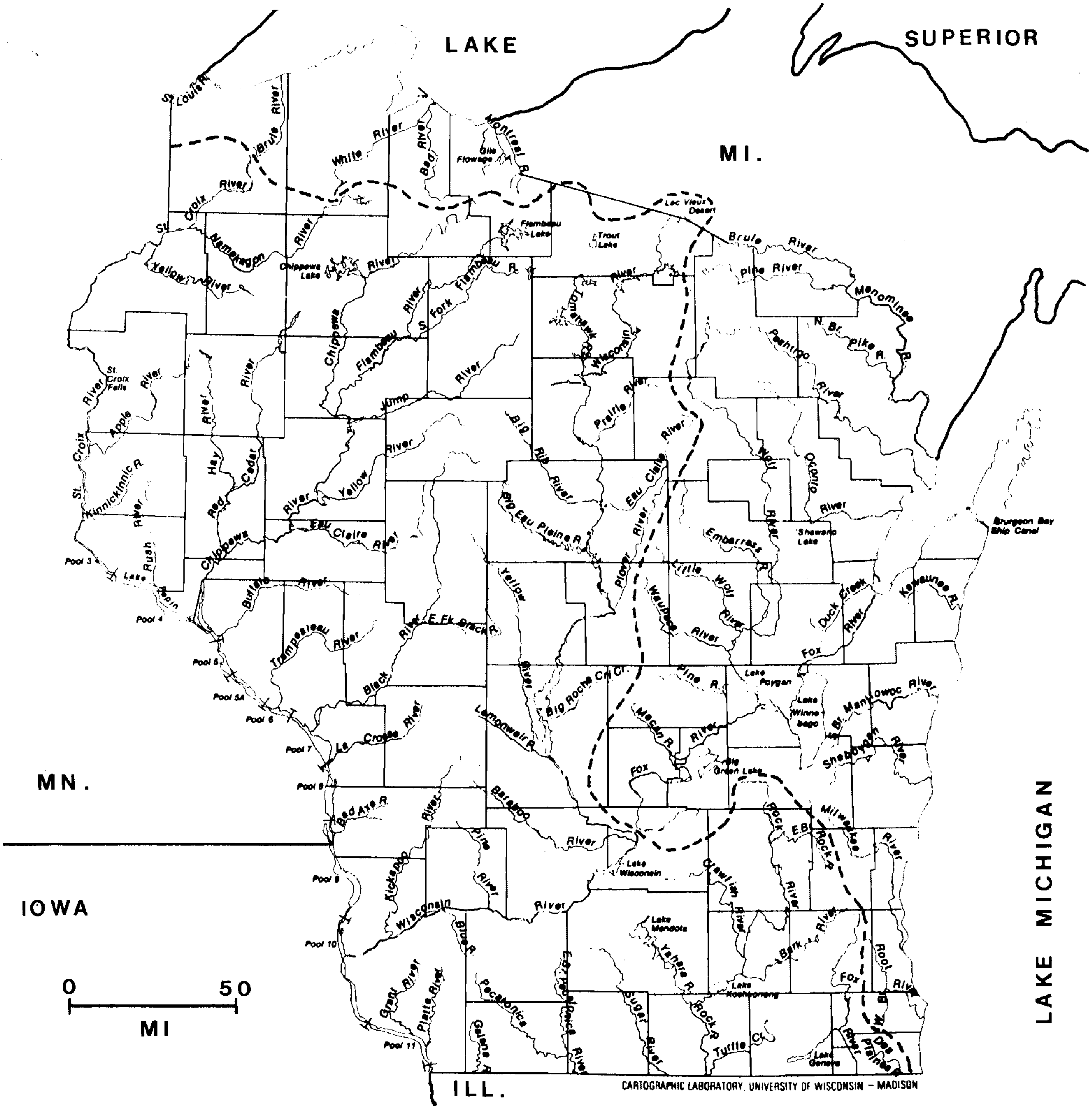


Fig. 1. Major drainages in Wisconsin.- - -The Mississippi-Great Lakes drainage basins.

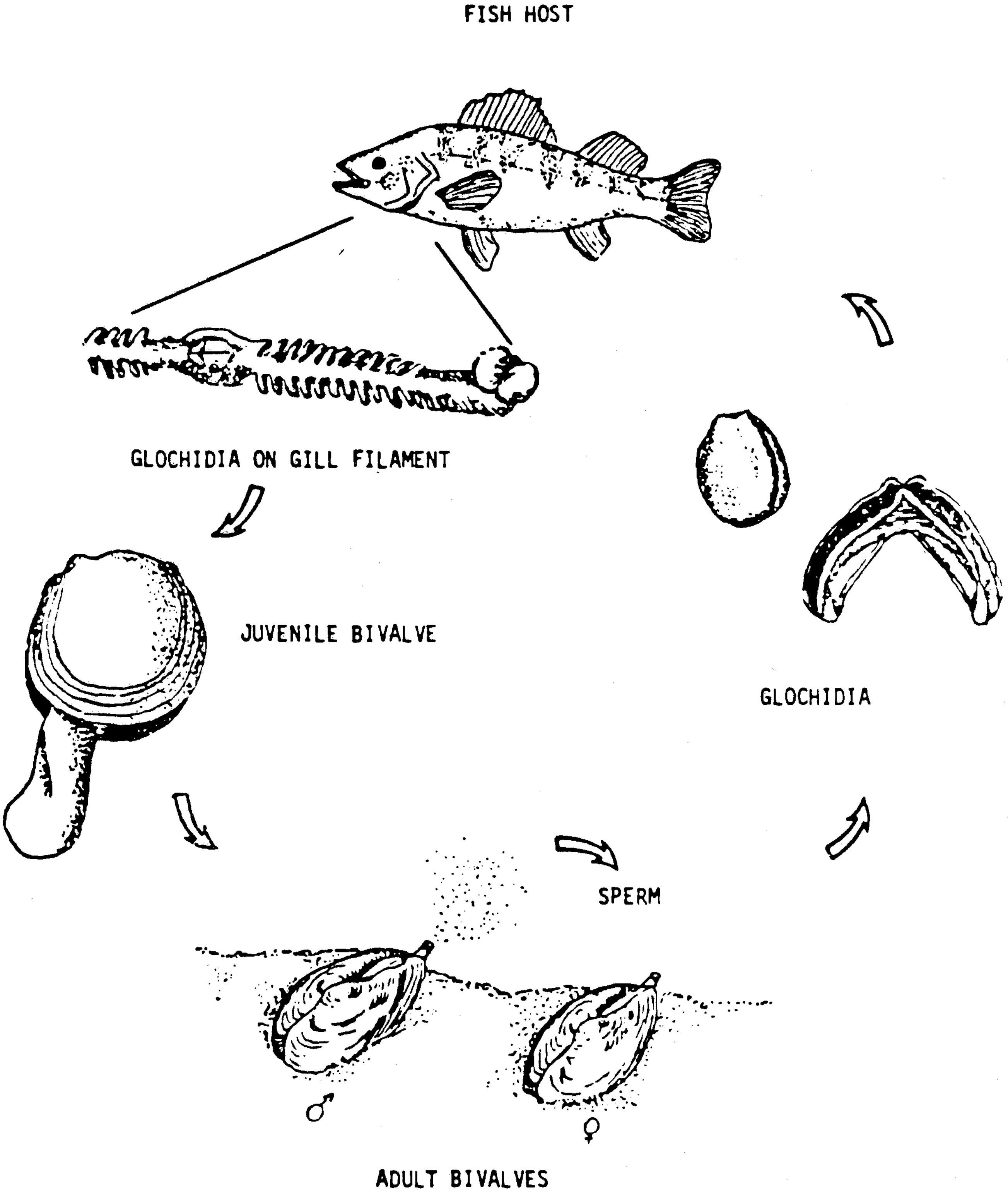


Fig. 2. **Unionid life cycle. (Not drawn to scale).**

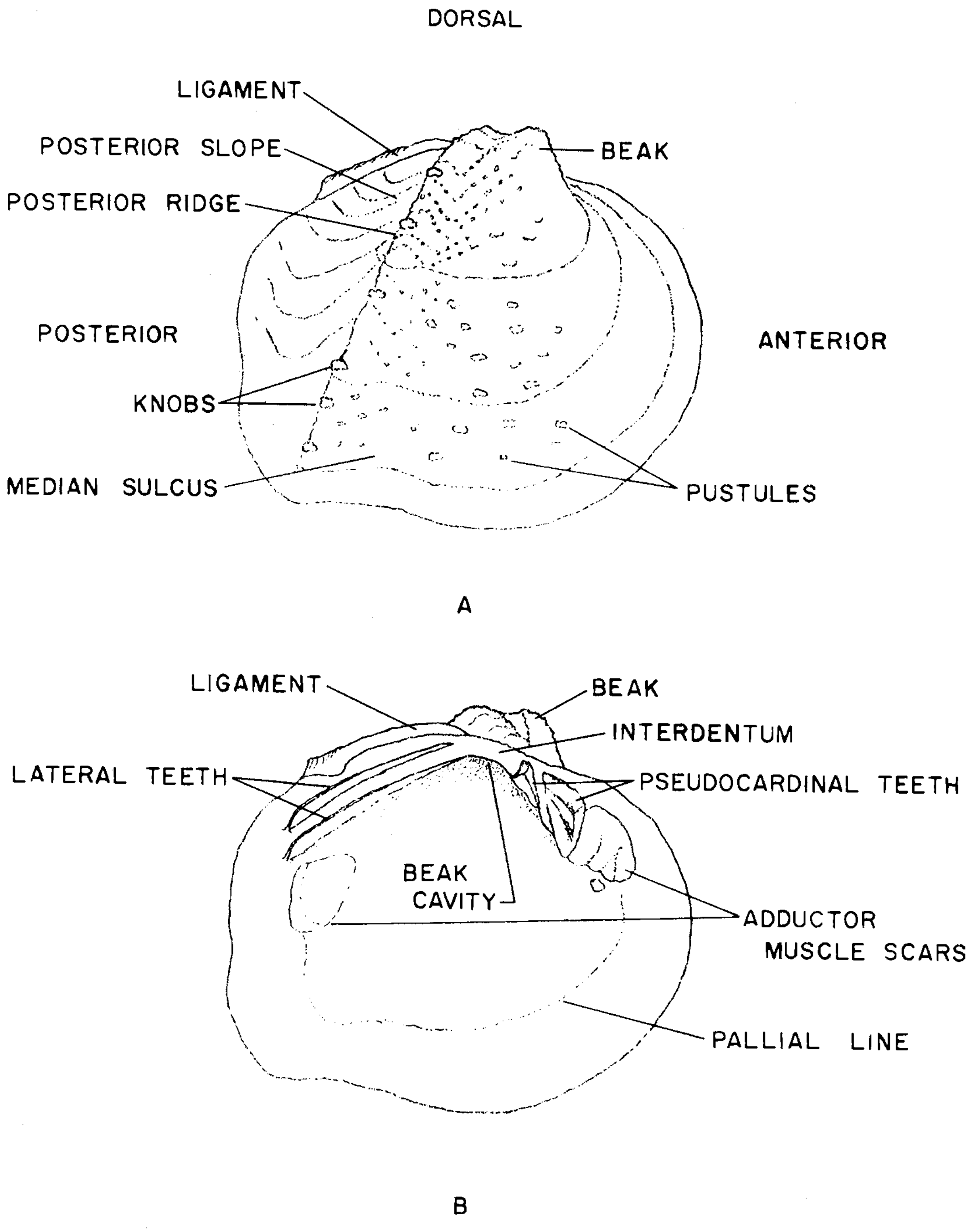


Fig. 3. **External and internal shell morphology: A, exterior view of the right valve; B, interior view of the left valve.**

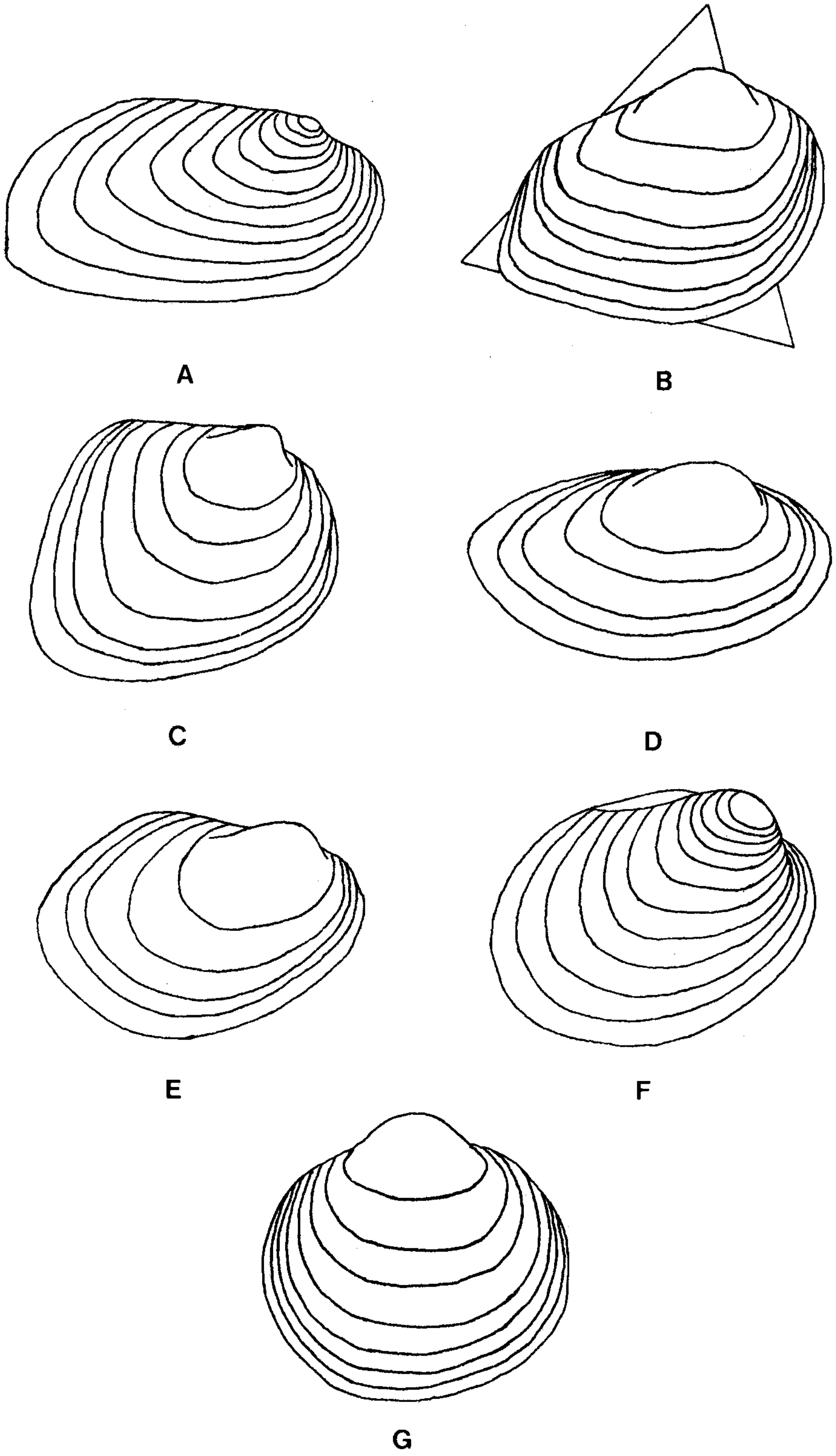


Fig. 4. Shell shapes: A, rhomboidal; B, triangular; C, quadrate; D, elliptical; E, oval; F, oval; G, round. Re-drawn from Burch (1975).

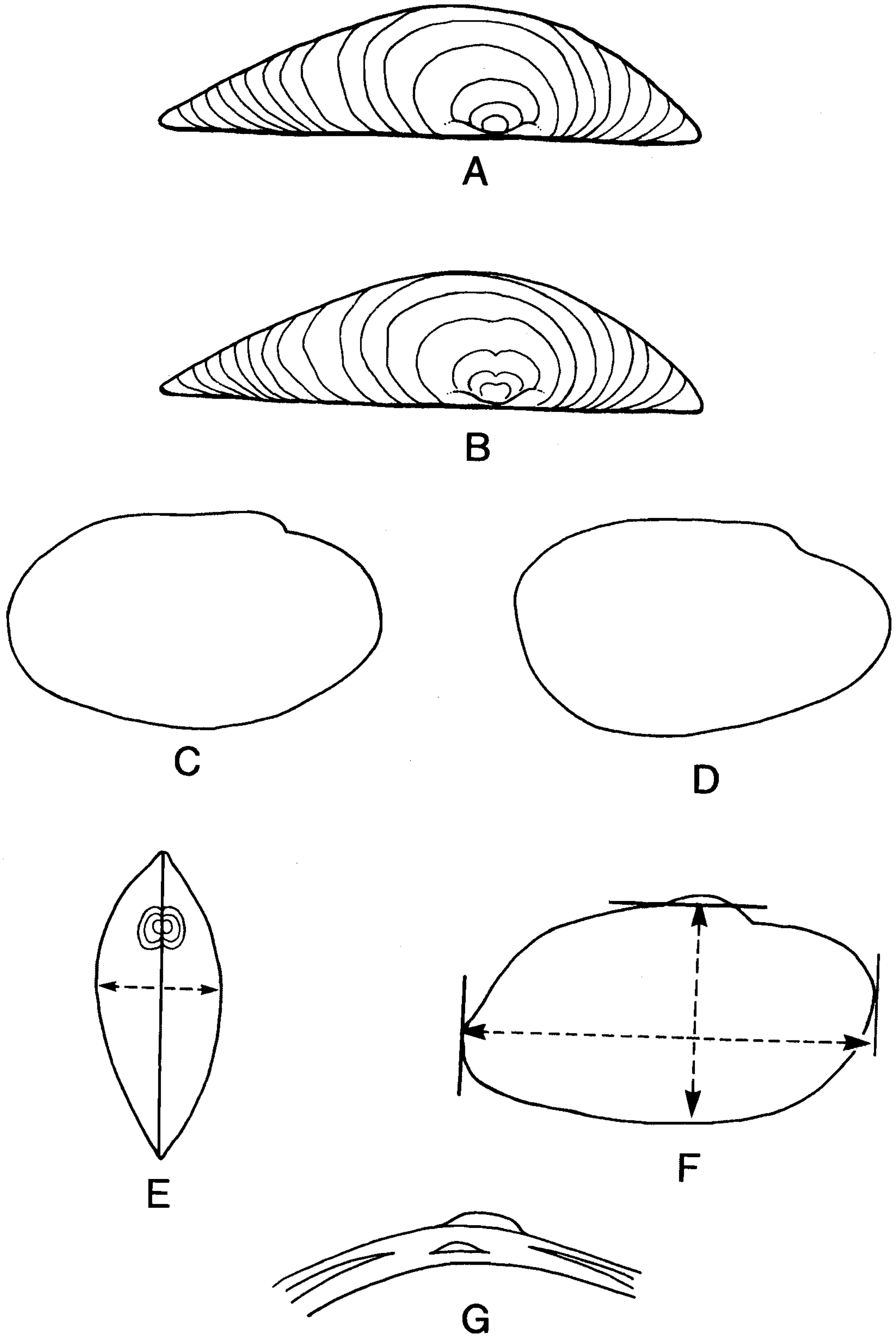
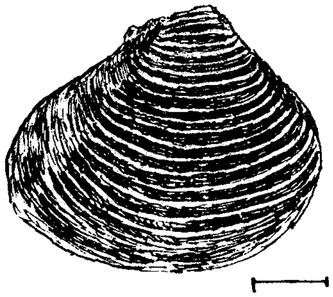
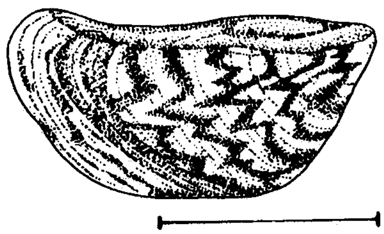


Fig. 5. Shell terminology: Beak sculpture - A, single - looped, B, double - looped; Sexual dimorphism- C, posteriorly pointed male, D, posteriorly truncate female; Shell dimensions - E, Shell width, F, Shell length and height; G, Hinge dentition showing central cardinal with anterior and posterior laterals. A and B re-drawn from Burch (1975).





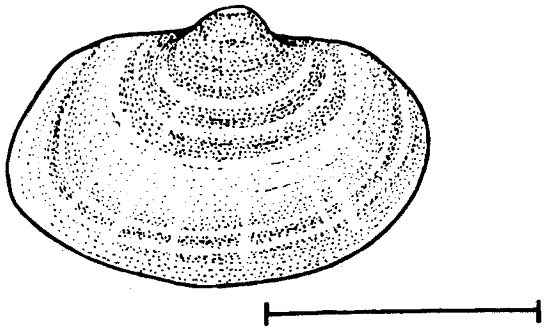


Fig. 6. *Corbicula fluminea.* (top)
Fig. 7. *Dreissena polymorpha.* (middle)
Fig. 8. *Sphaerium transversum.* (bottom)
Scale line = 1 cm.

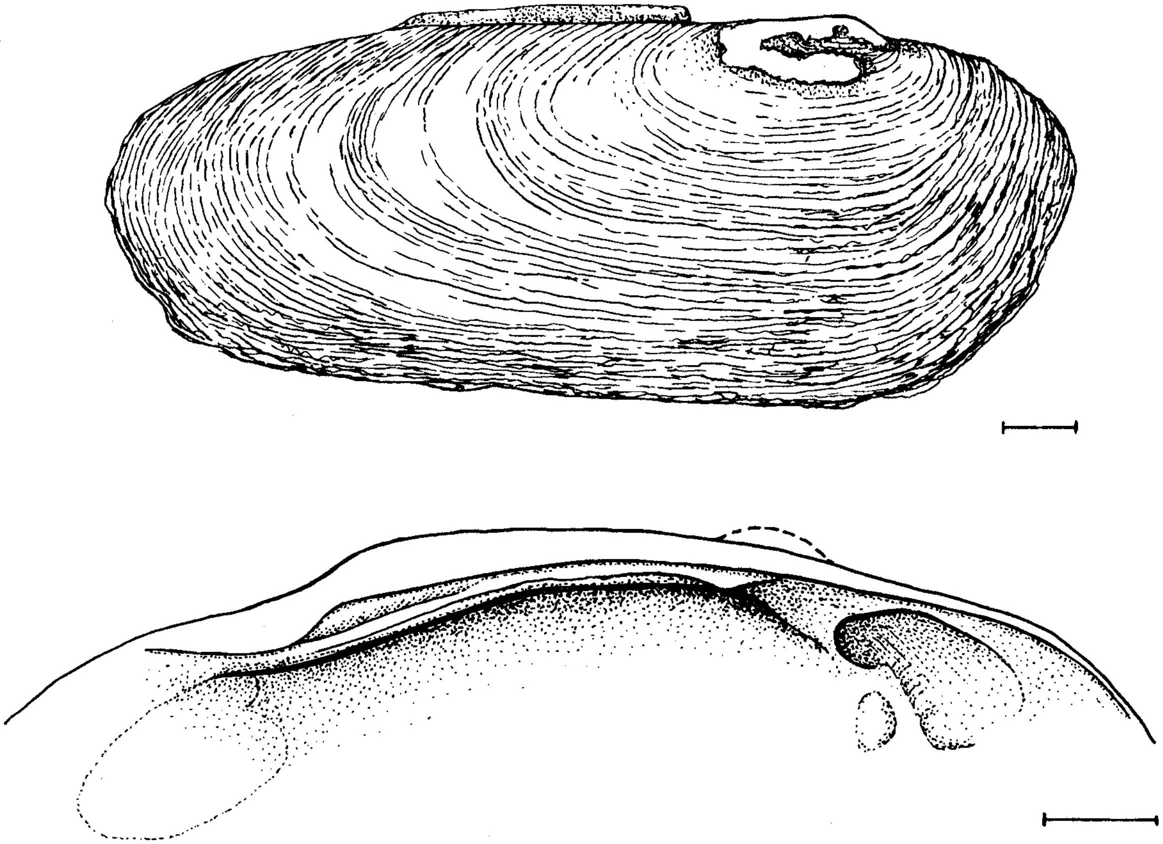


Fig. 9. *Cumberlandia mondonta* - right valve and hinge plate of left valve.
Scale line = 1 cm.

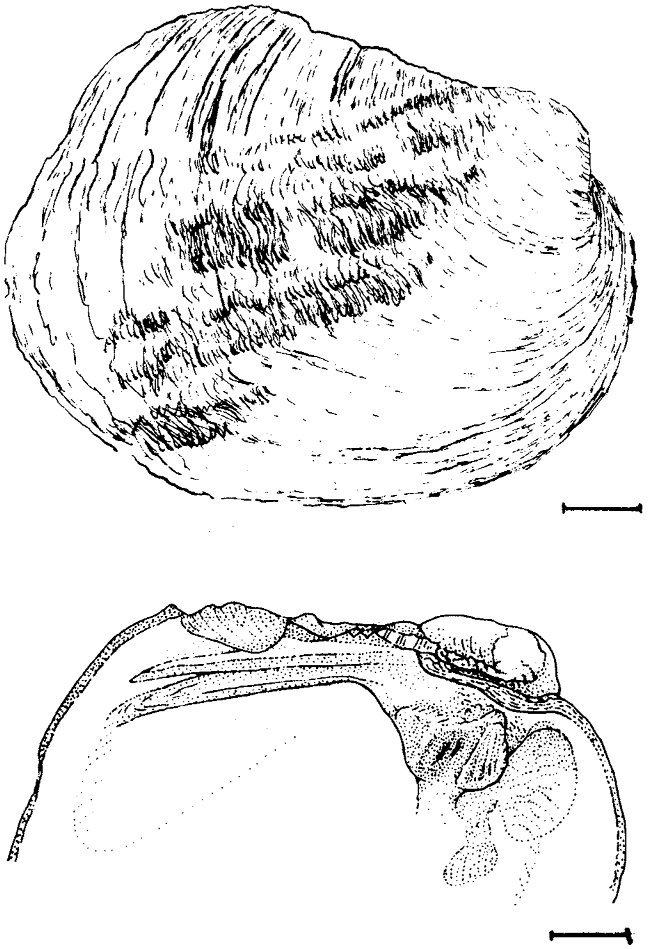


Fig. 10. *Amblema plicata* - right valve and hinge plate of left valve. Scale line = 1 cm.

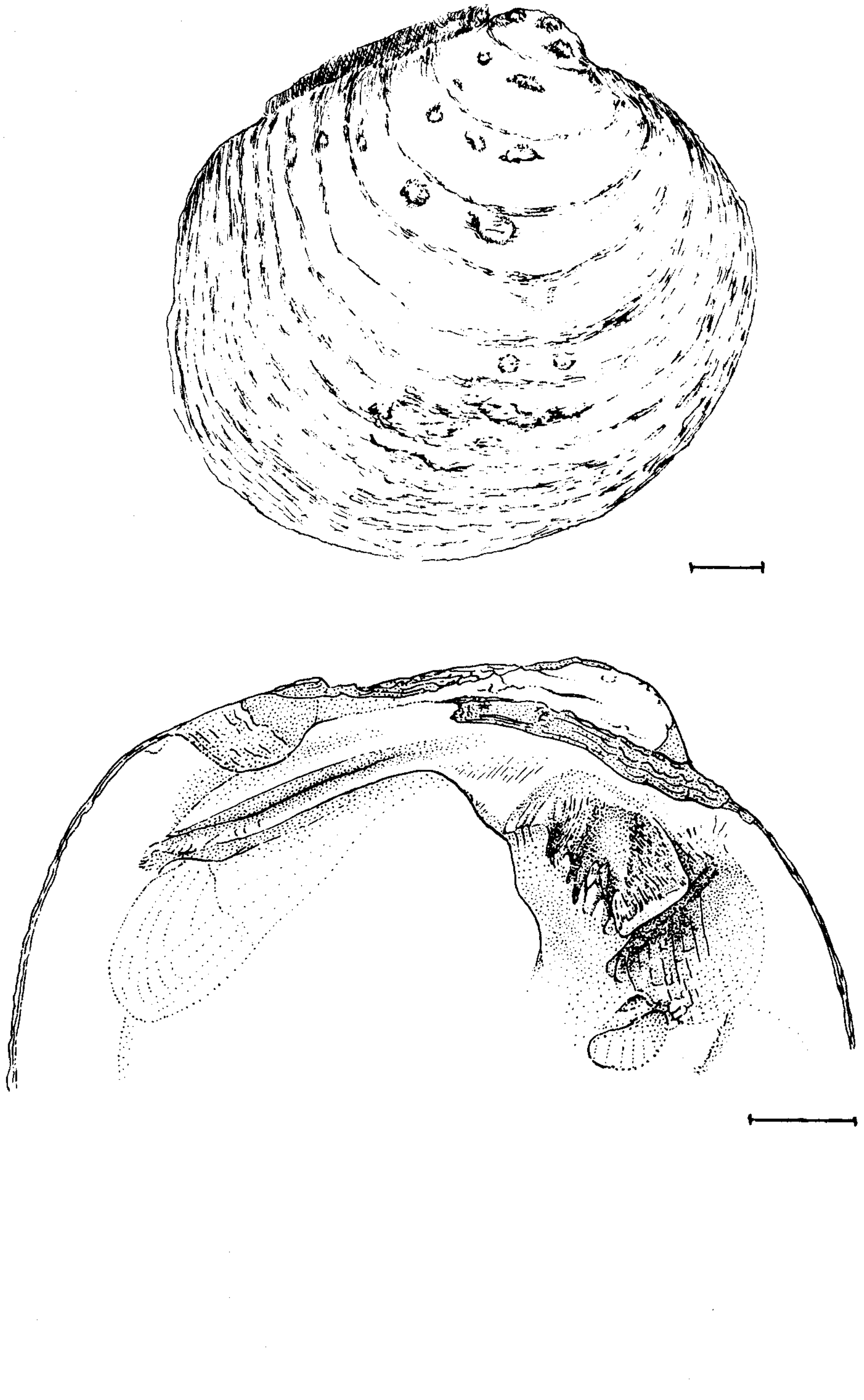


Fig. 11. *Cyclonaias tuberculata* - right valve and hinge plate of left valve. Scale line = 1 cm.

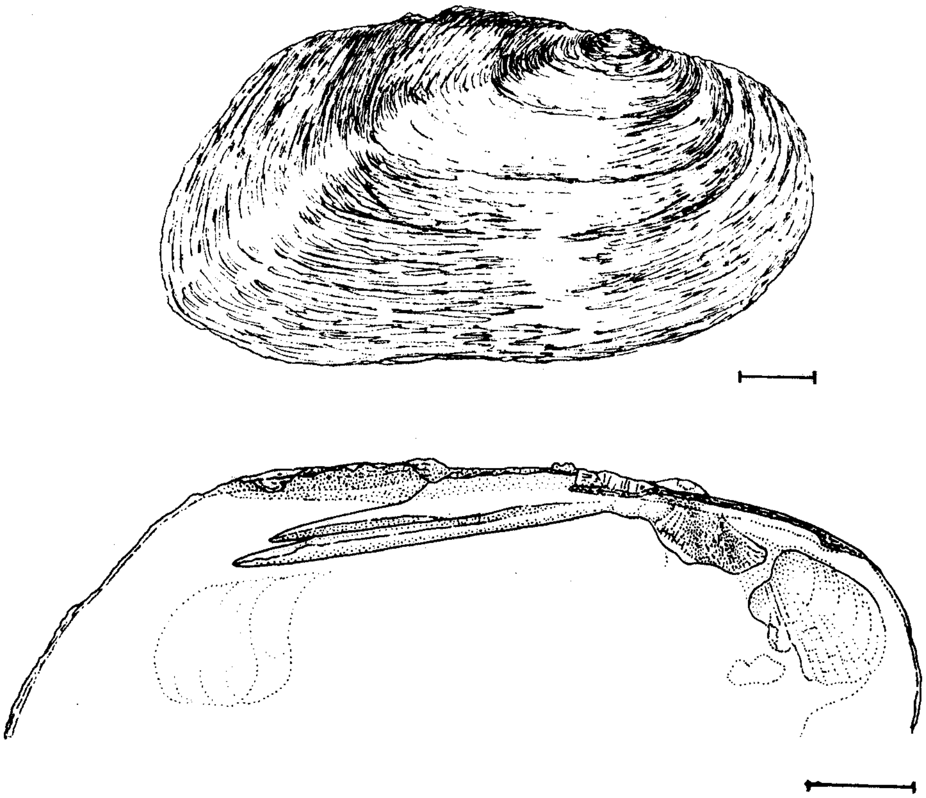


Fig. 12. *Elliptio complanata* - right valve and hinge plate of left valve. Scale line = 1 cm.

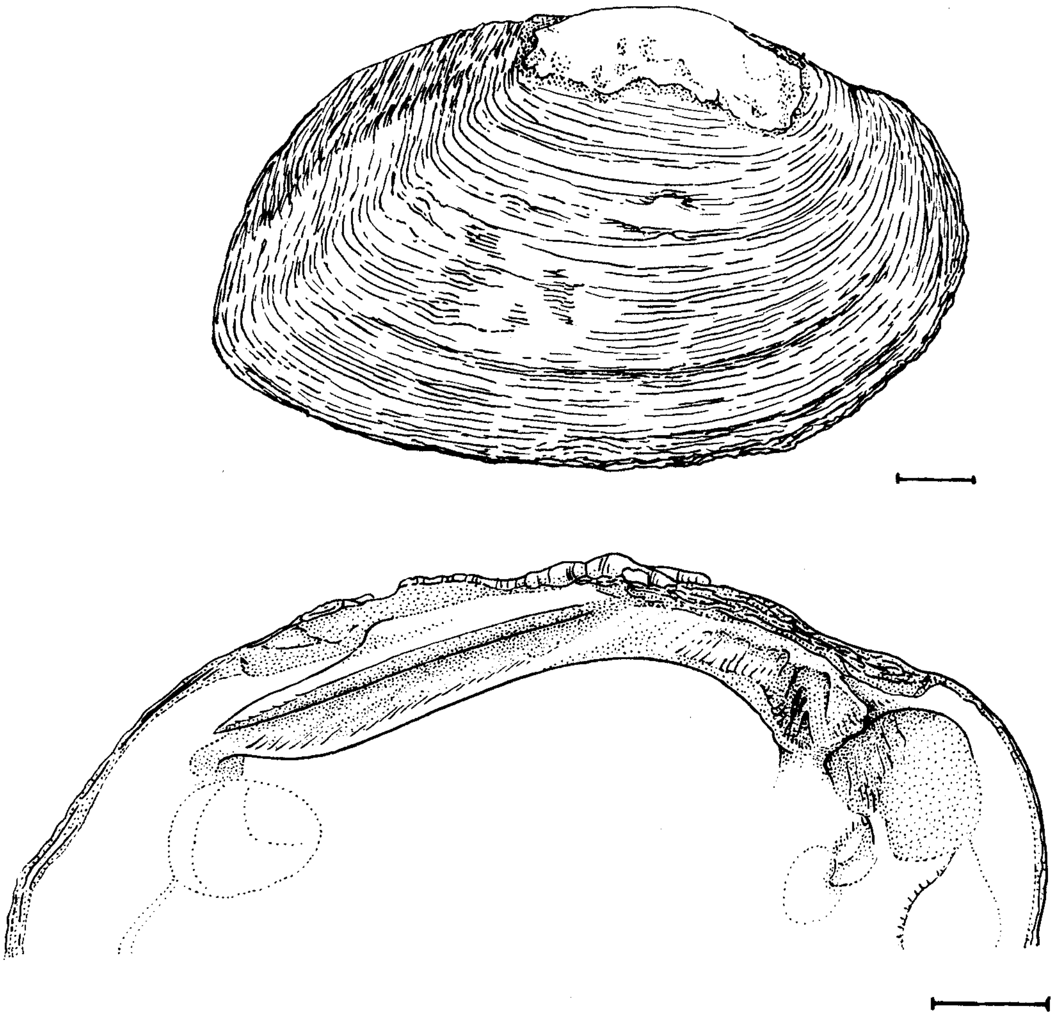


Fig. 13. *Elliptio crassidens* - right valve and hinge plate of left valve. Scale line = 1 cm.

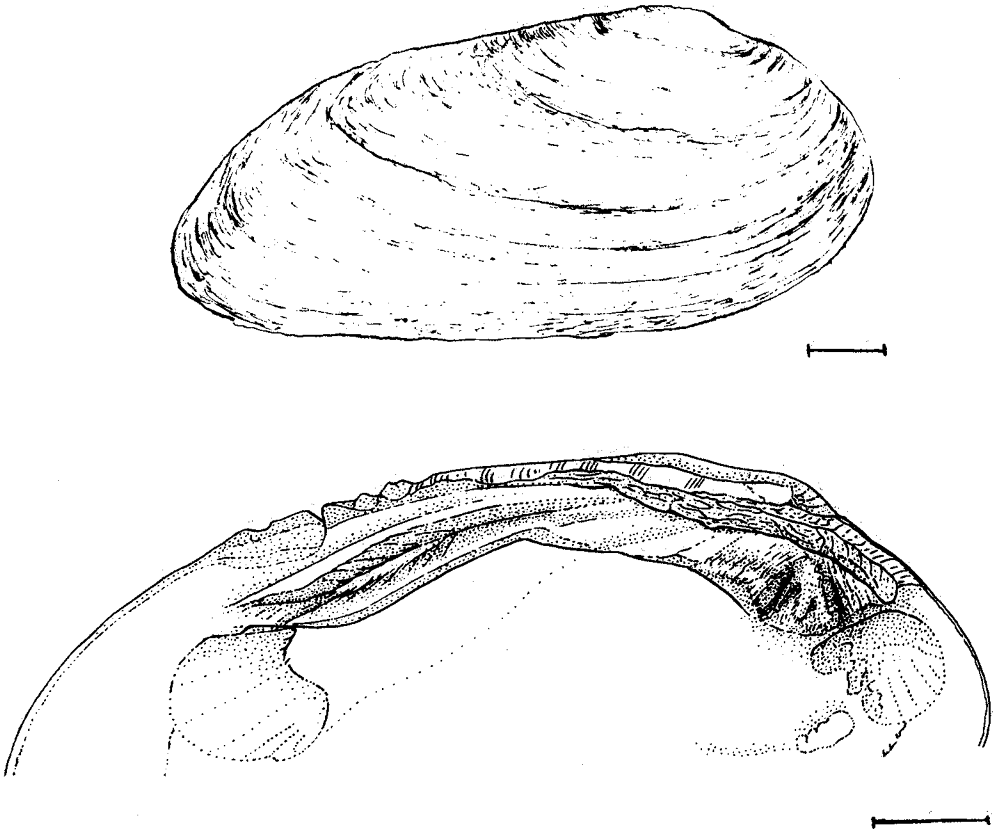


Fig. 14. *Elliptio dilatata* - right valve and hinge plate of left valve. Scale line = 1 cm.

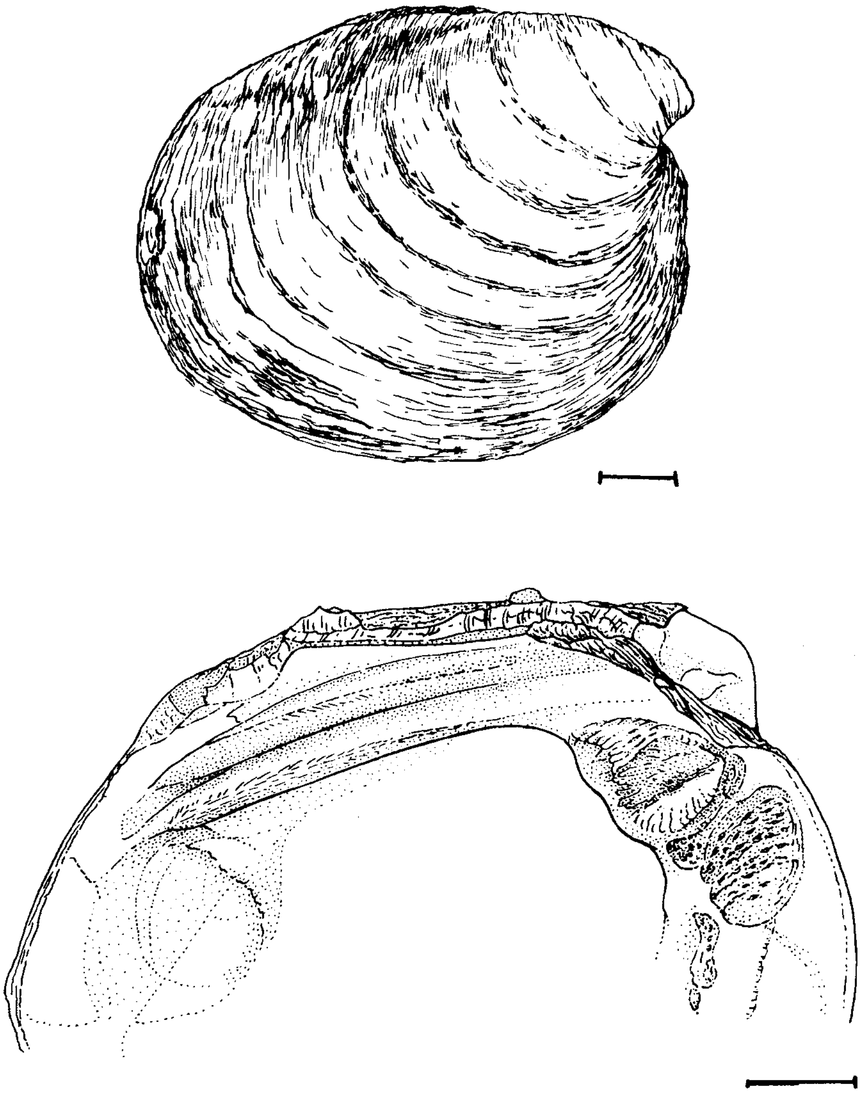


Fig. 15. *Fusconaia ebena* - right valve and hinge plate of left valve. Scale line = 1 cm.

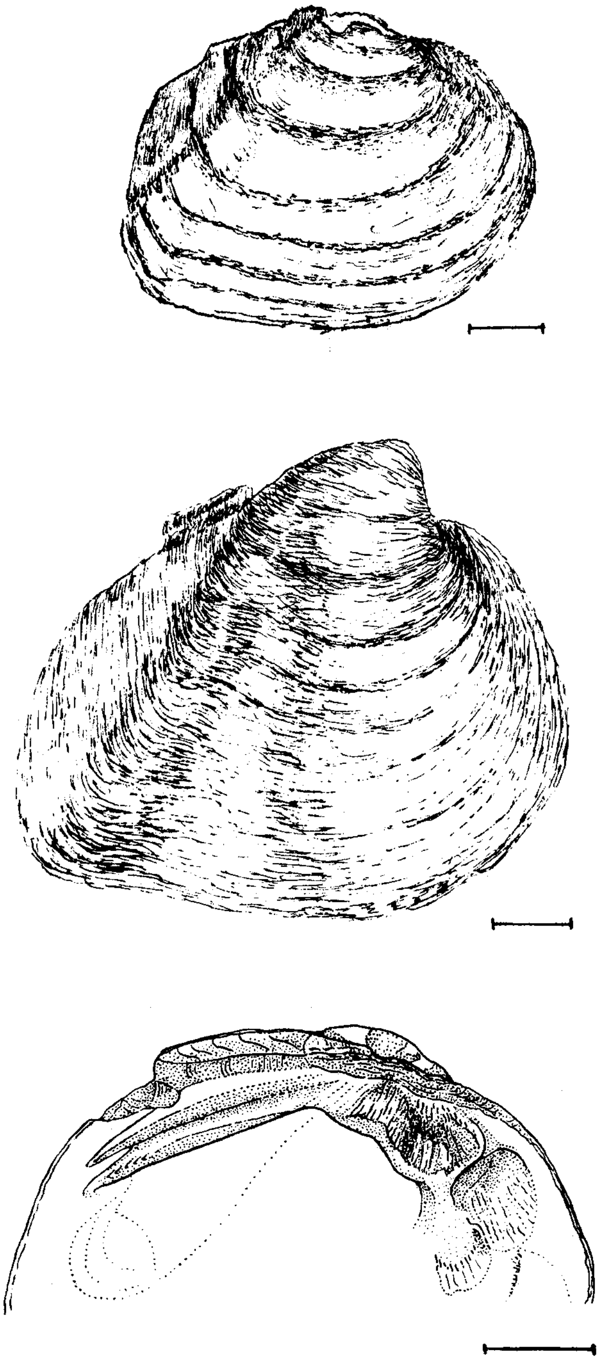


Fig. 16. *Fusconaia flava* - right valve of form *flava* (top), form *undata* (middle), and hinge plate of left valve. Scale line = 1 cm.

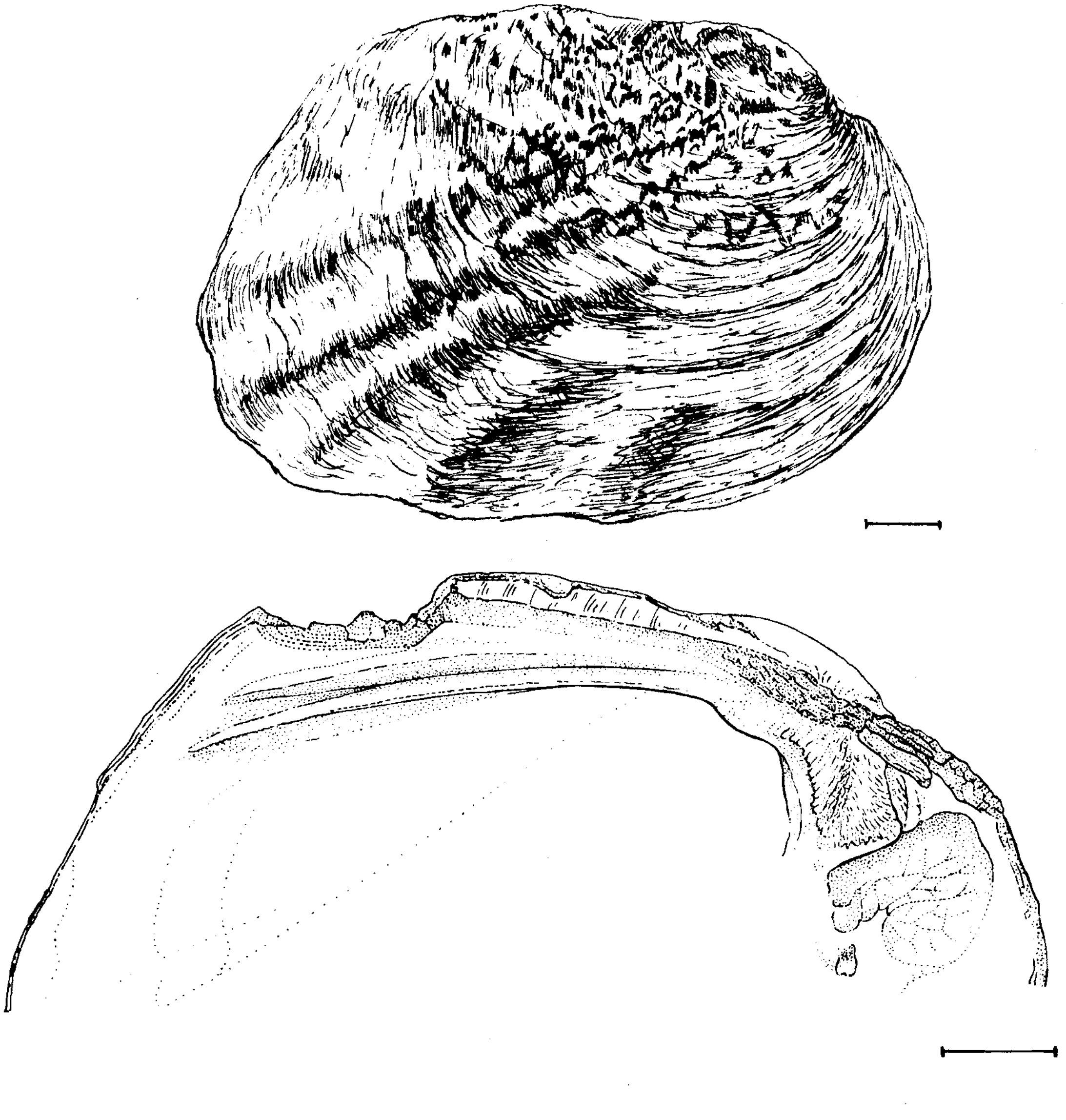


Fig. 17. *Megalonaias nervosa* - right valve and hinge plate of left valve. Scale line = 1 cm.

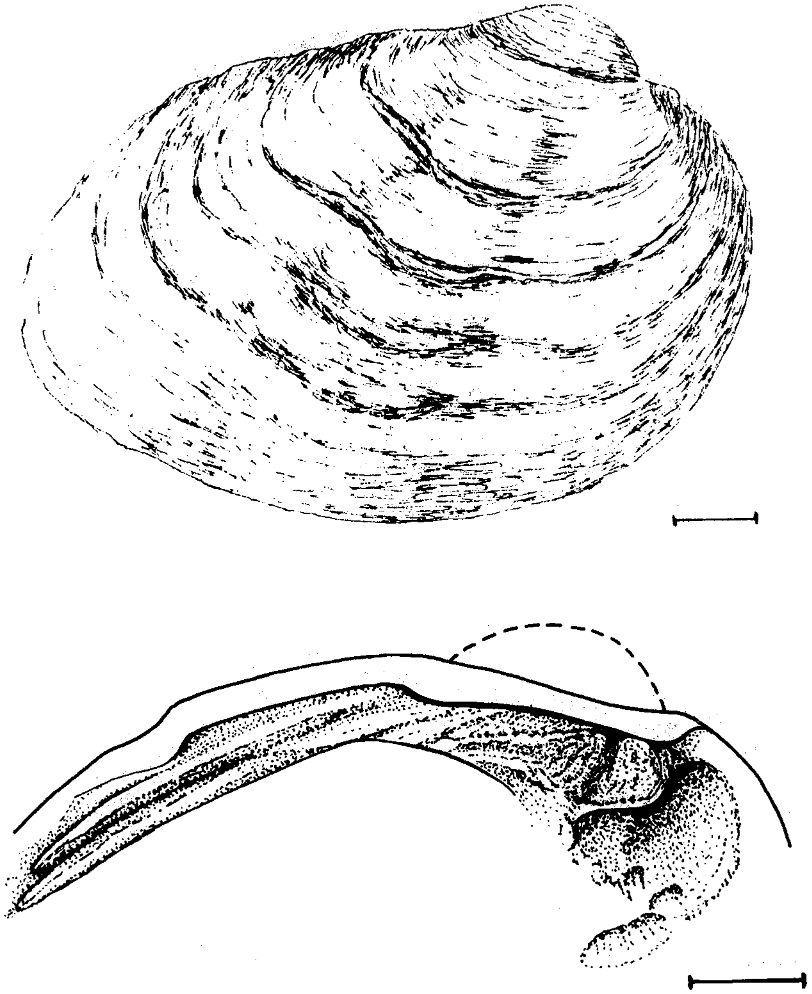


Fig. 18. *Plethobasus cyphyus* - right valve and hinge plate of left valve. Scale line = 1 cm.

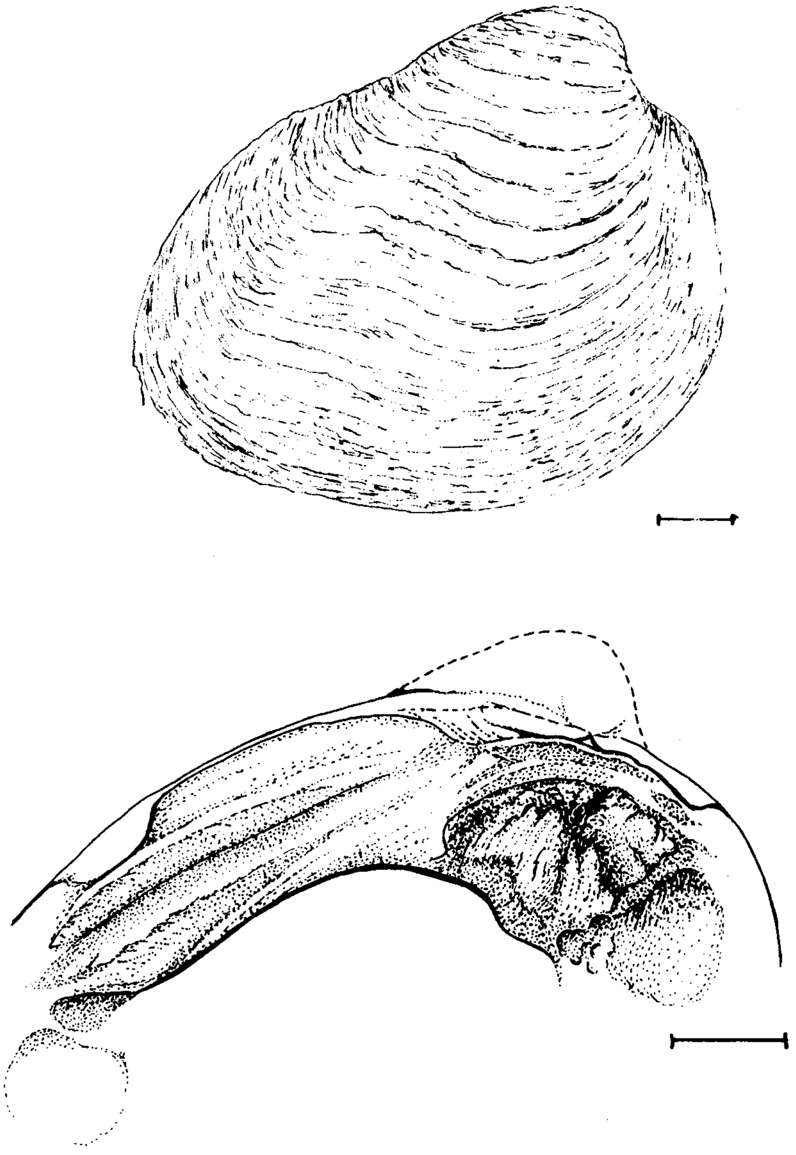


Fig. 19. *Pleurobema cordatum* - right valve and hinge plate of left valve. Scale line = 1 cm.

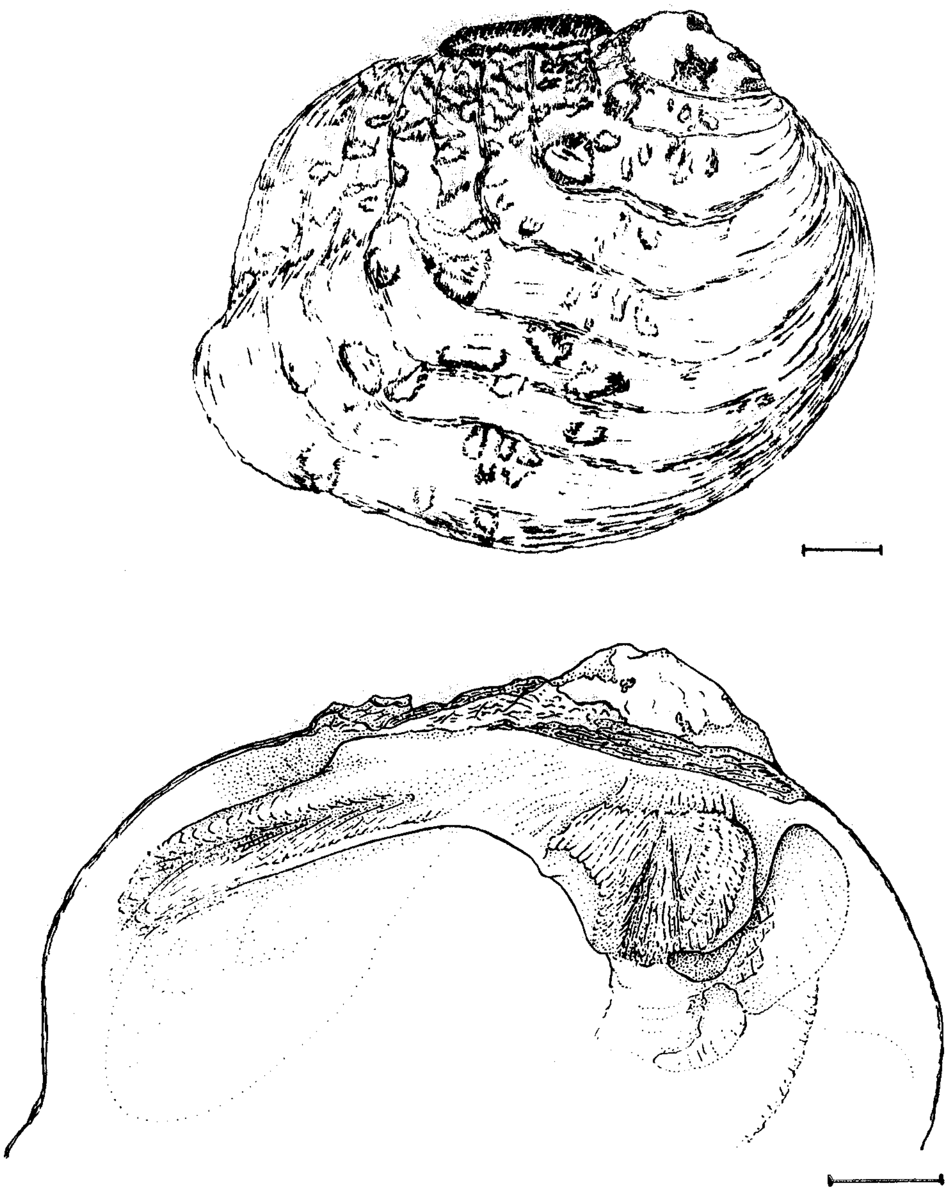


Fig. 20. *Quadrula metanevra* - right valve and hinge plate of left valve. Scale line = 1 cm.

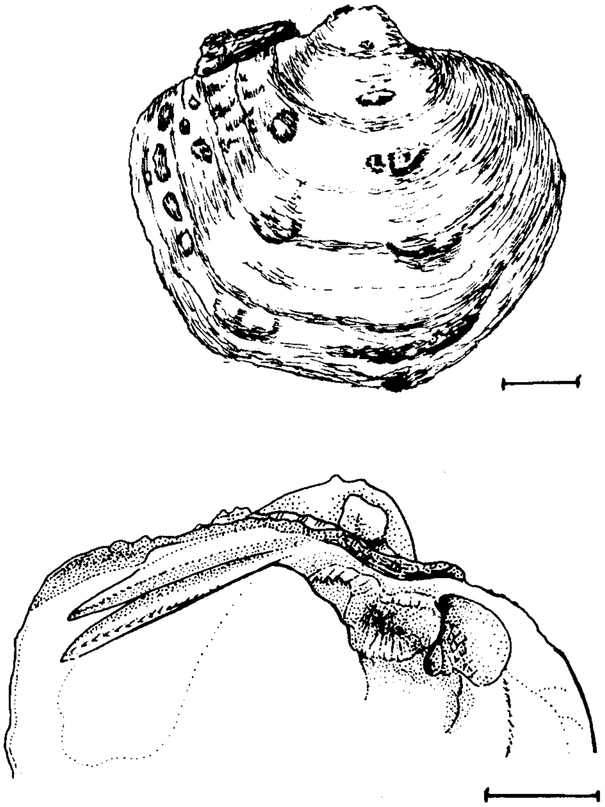


Fig. 21. *Quadrula nodulata* - right valve and hinge plate of left valve.
Scale line = 1 cm.

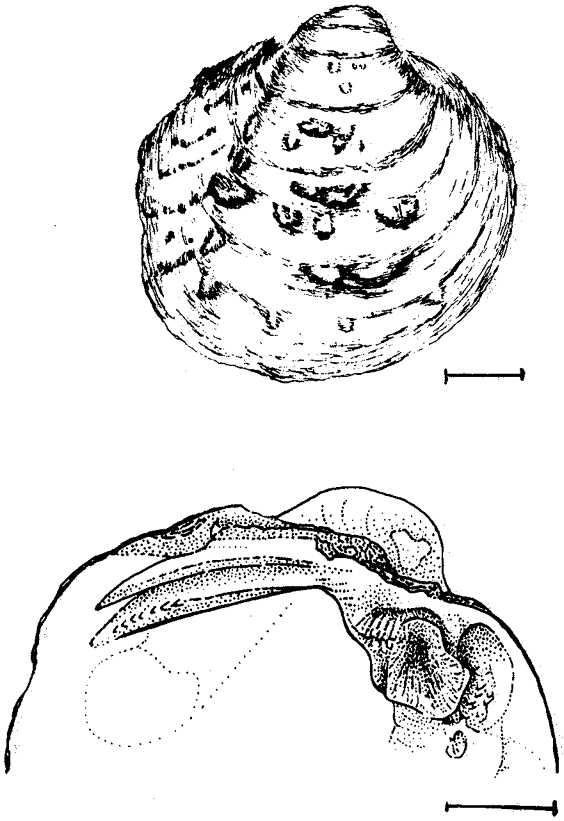


Fig. 22. *Quadrula pustulosa* - right valve and hinge plate of left valve. Scale line = 1 cm.

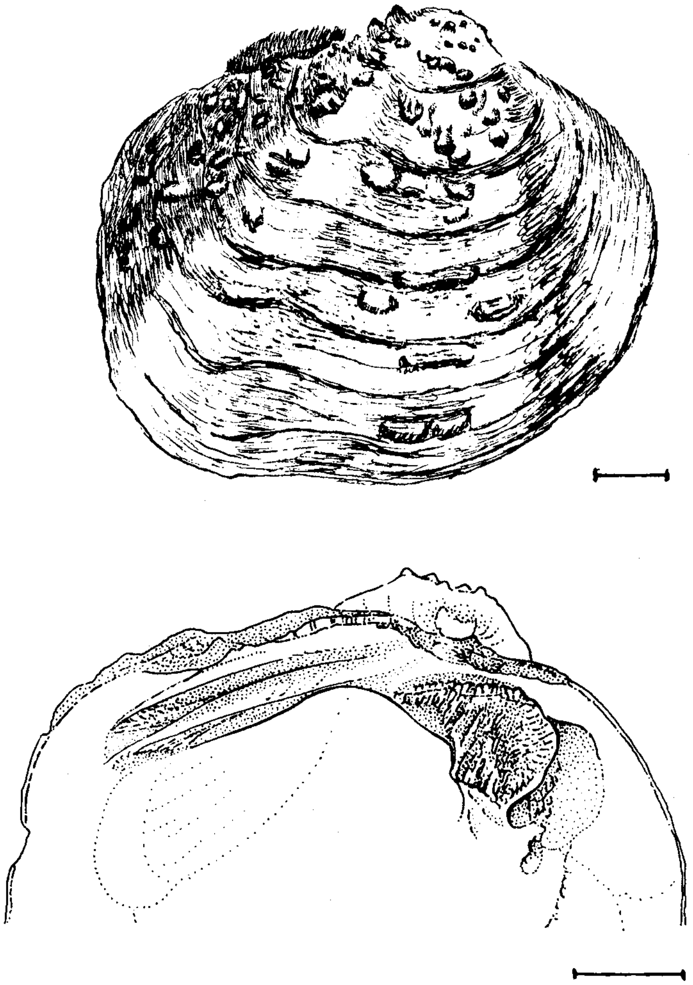


Fig. 23. *Quadrula quadrula* - right valve and hinge plate of left valve. Scale line = 1 cm.

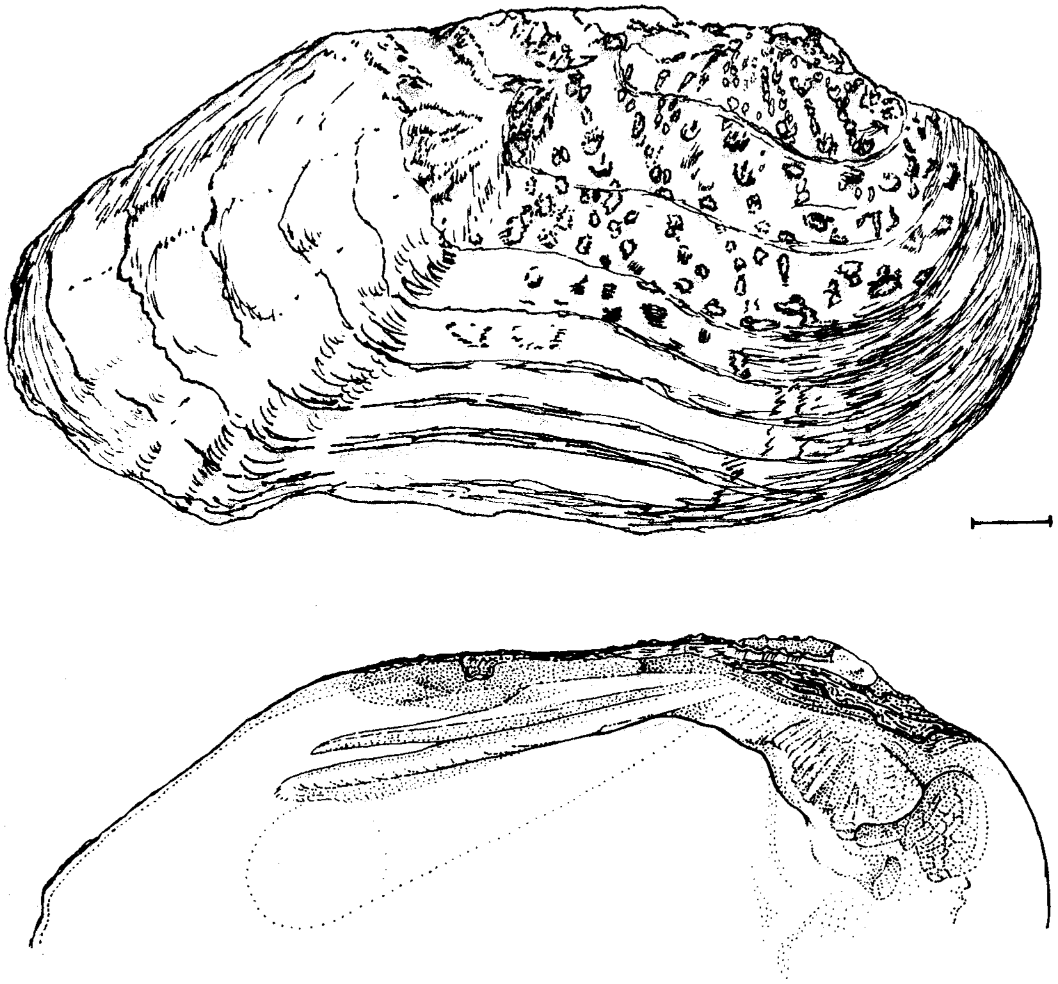


Fig. 24. *Tritogonia verrucosa* - right valve and hinge plate of left valve. Scale line = 1 cm.

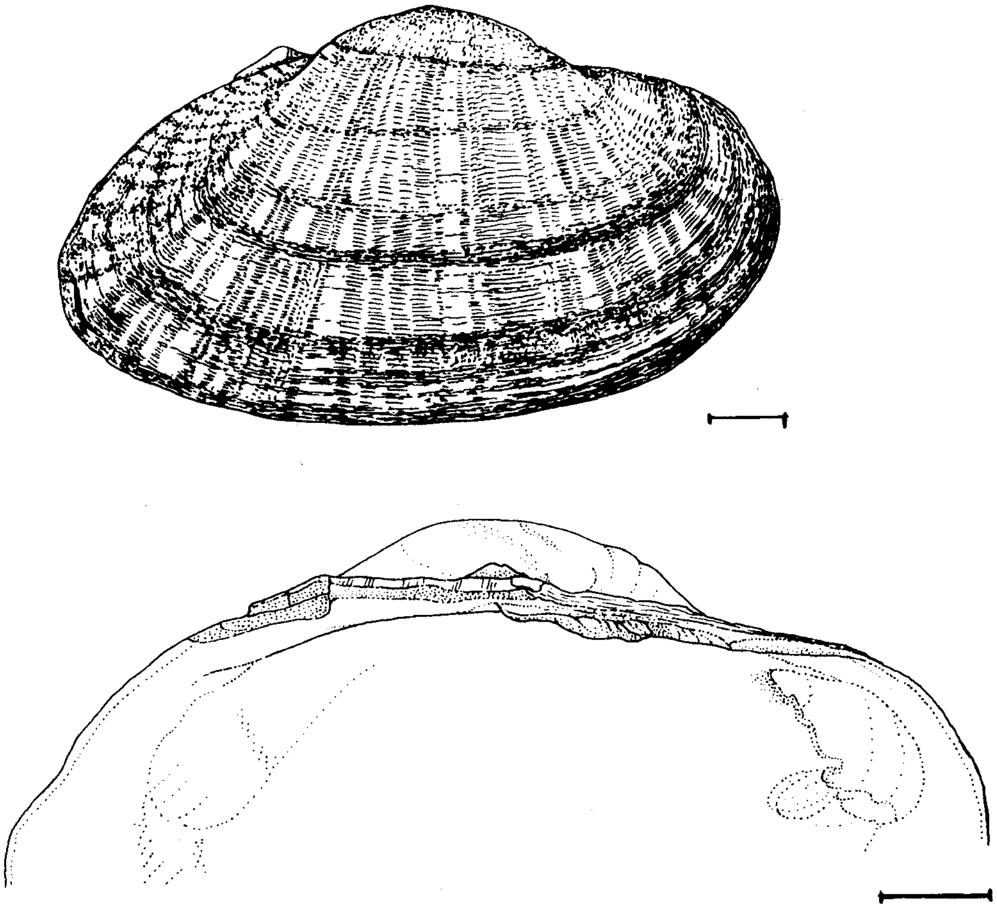


Fig. 25. *Alasmidonta marginata* - right valve and hinge plate of left valve. Scale line = 1 cm.

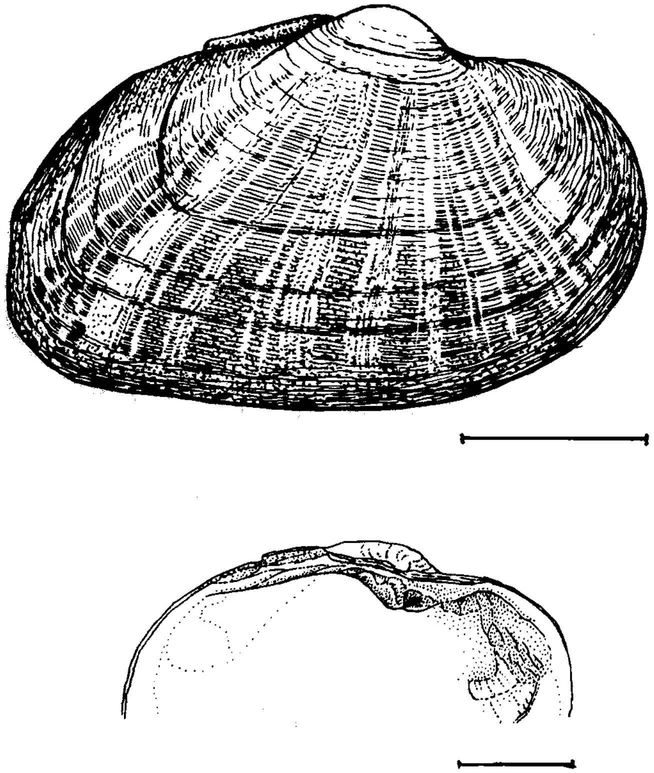


Fig. 26. *Alasmidonta viridis* - right valve and hinge plate of left valve. Scale line = 1 cm.

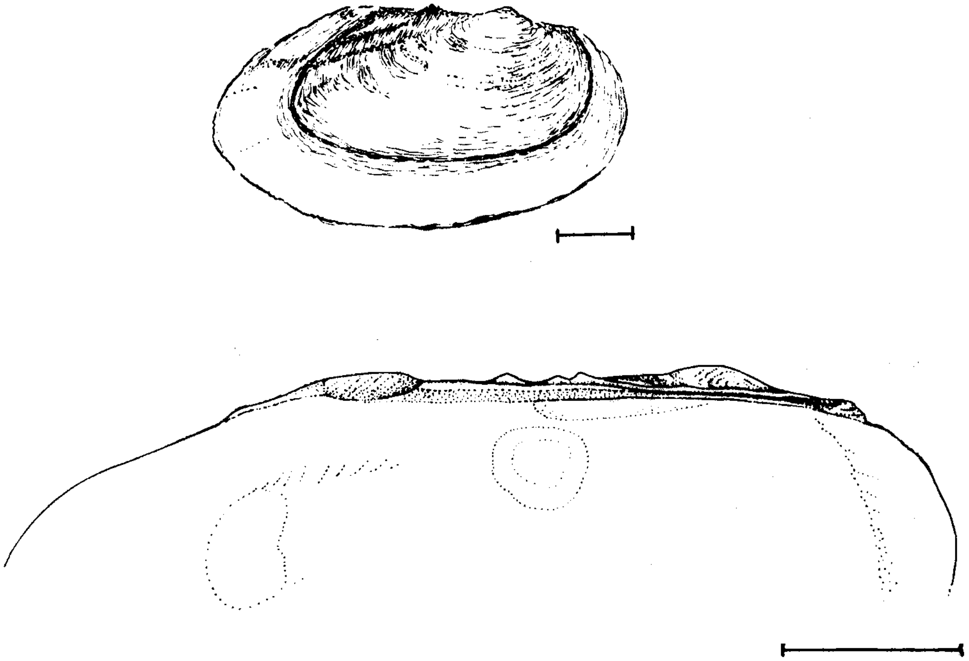
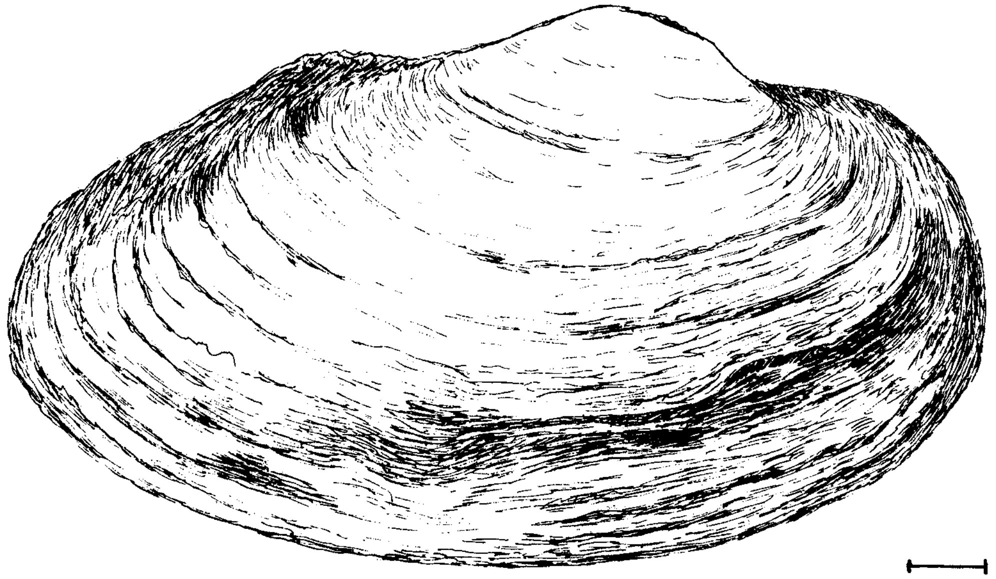


Fig. 27. *Anodonta cataracta* - right valve and hinge plate of left valve. Scale line = 1 cm.



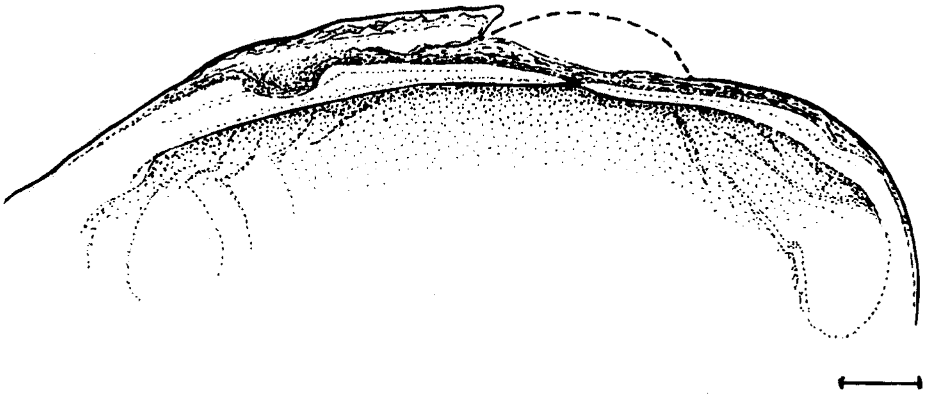


Fig. 28. *Anodonta grandis* - right valve and hinge plate of left valve. Scale line = 1 cm.

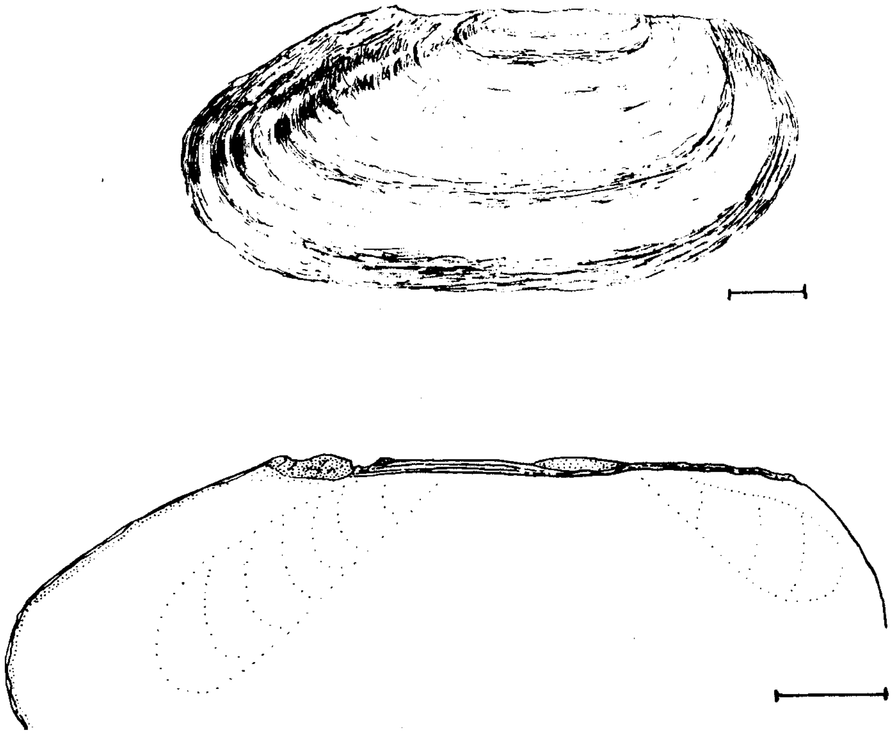


Fig. 29. *Anodonta imbecillis* - right valve and hinge plate of left valve. Scale line = 1 cm.

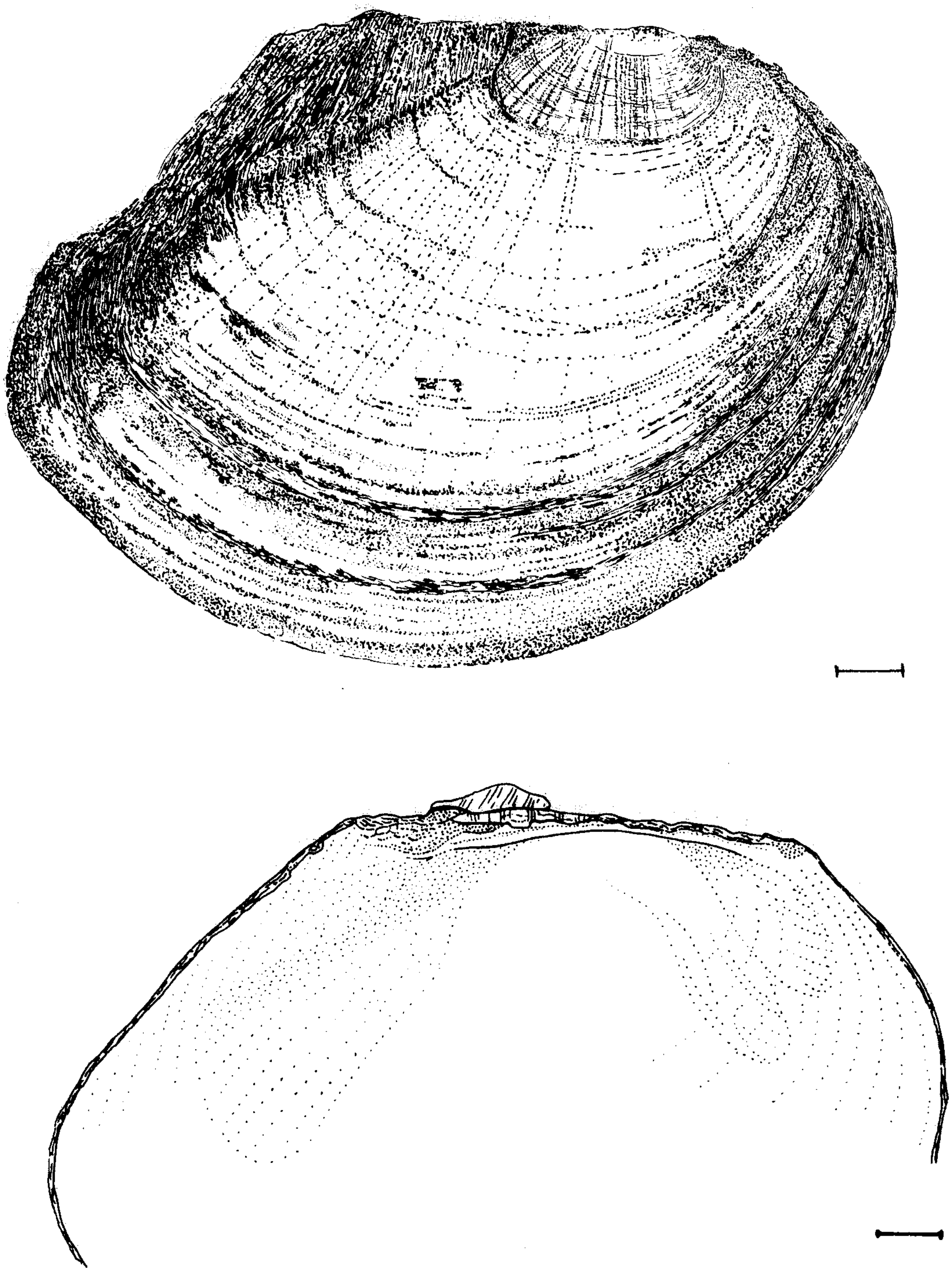


Fig. 30. *Anodonta suborbiculata* - right valve and hinge plate of left valve. Scale line = 1 cm.

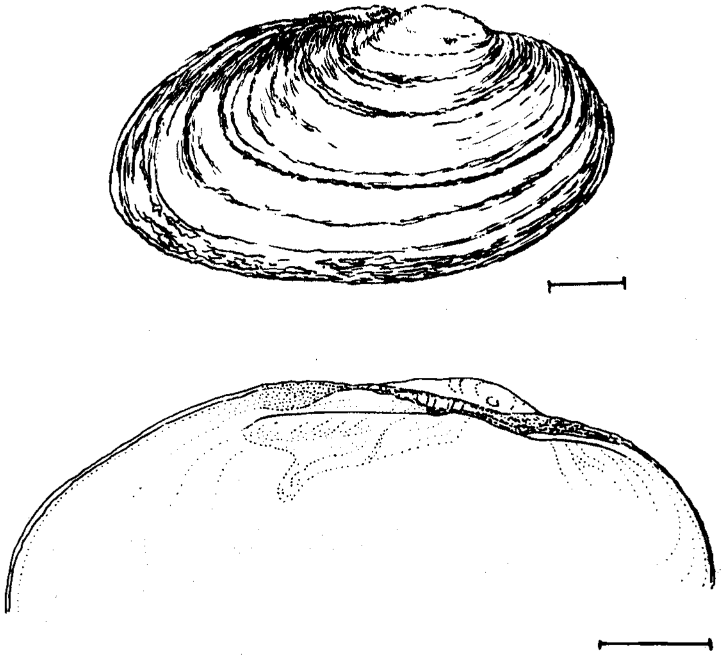


Fig. 31. *Anodontoides ferussacianus* - right valve and hinge plate of left valve. Scale line = 1 cm.

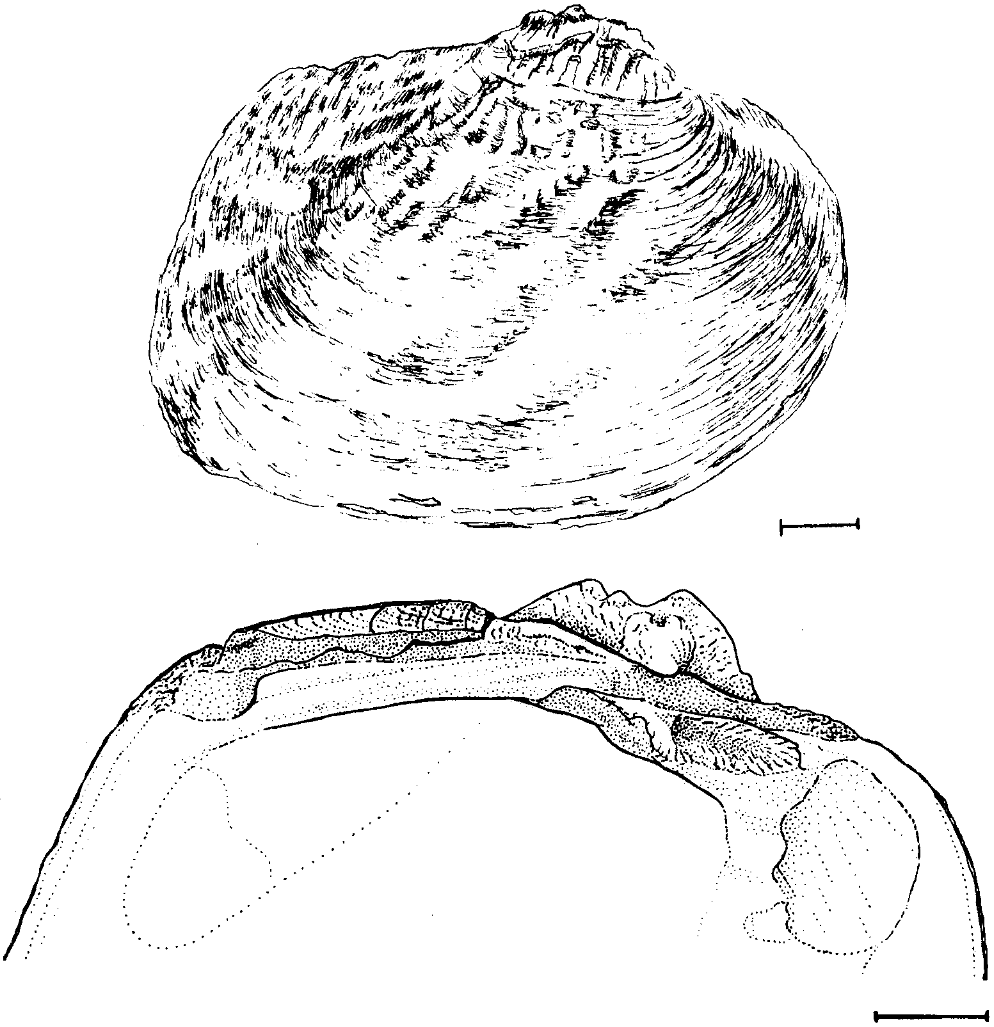


Fig. 32. *Arcidens confragosus* - right valve and hinge plate of left valve. Scale line = 1 cm.

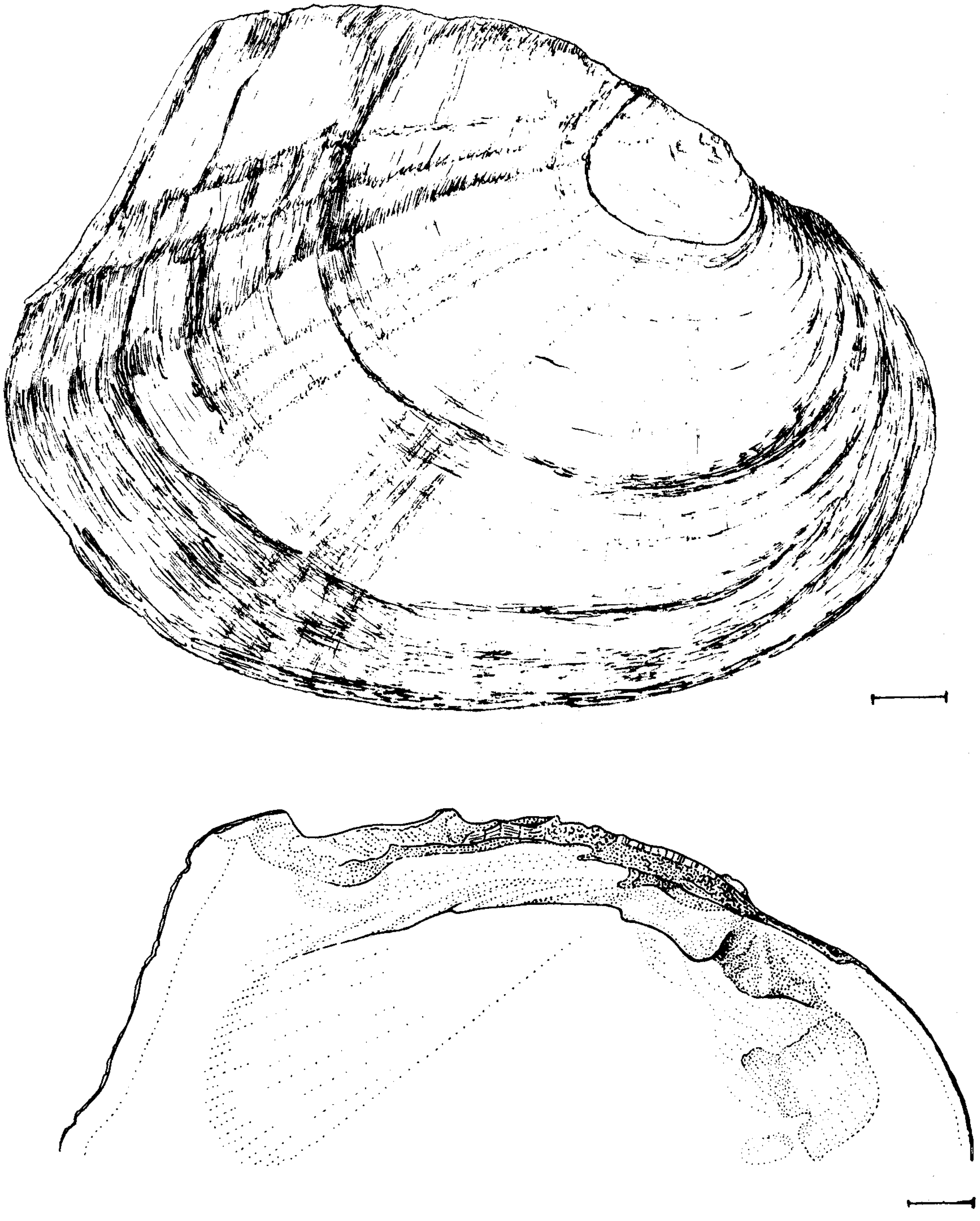


Fig. 33. *Lasmigona complanata* - right valve and hinge plate of left valve. Scale line = 1 cm.

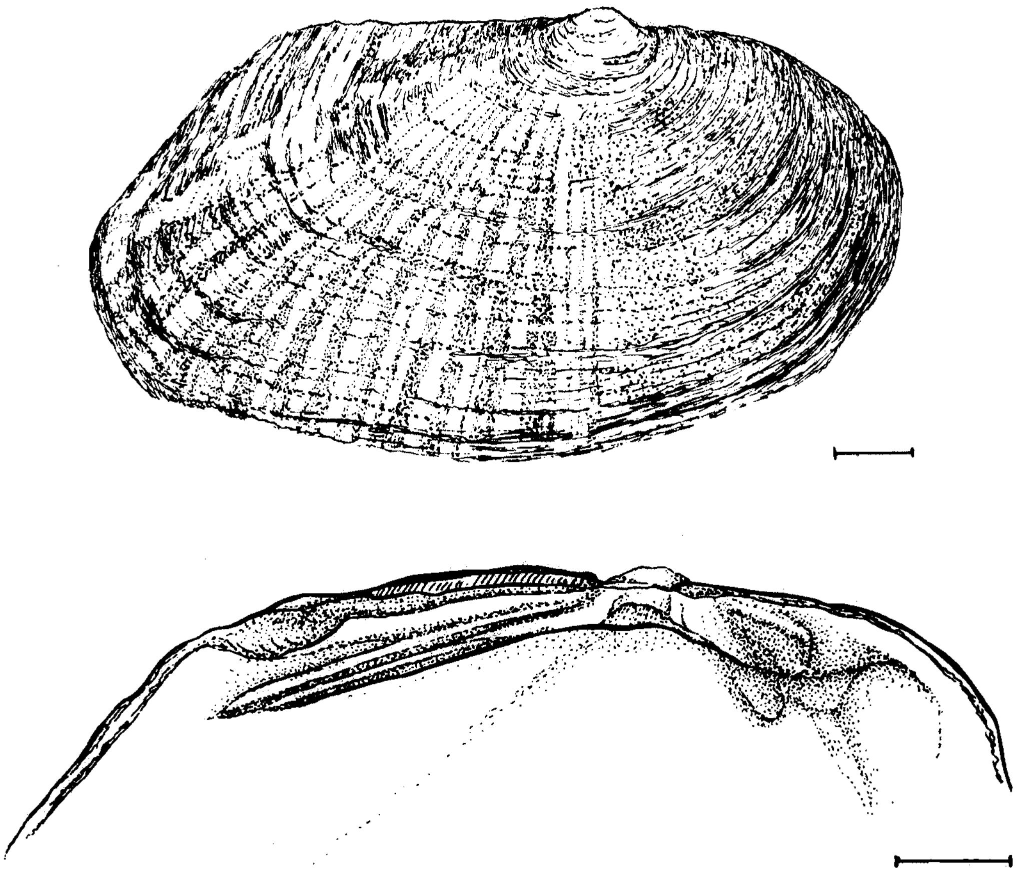


Fig. 34. *Lasmigona compressa* - right valve and hinge plate of left valve. Scale line = 1 cm.

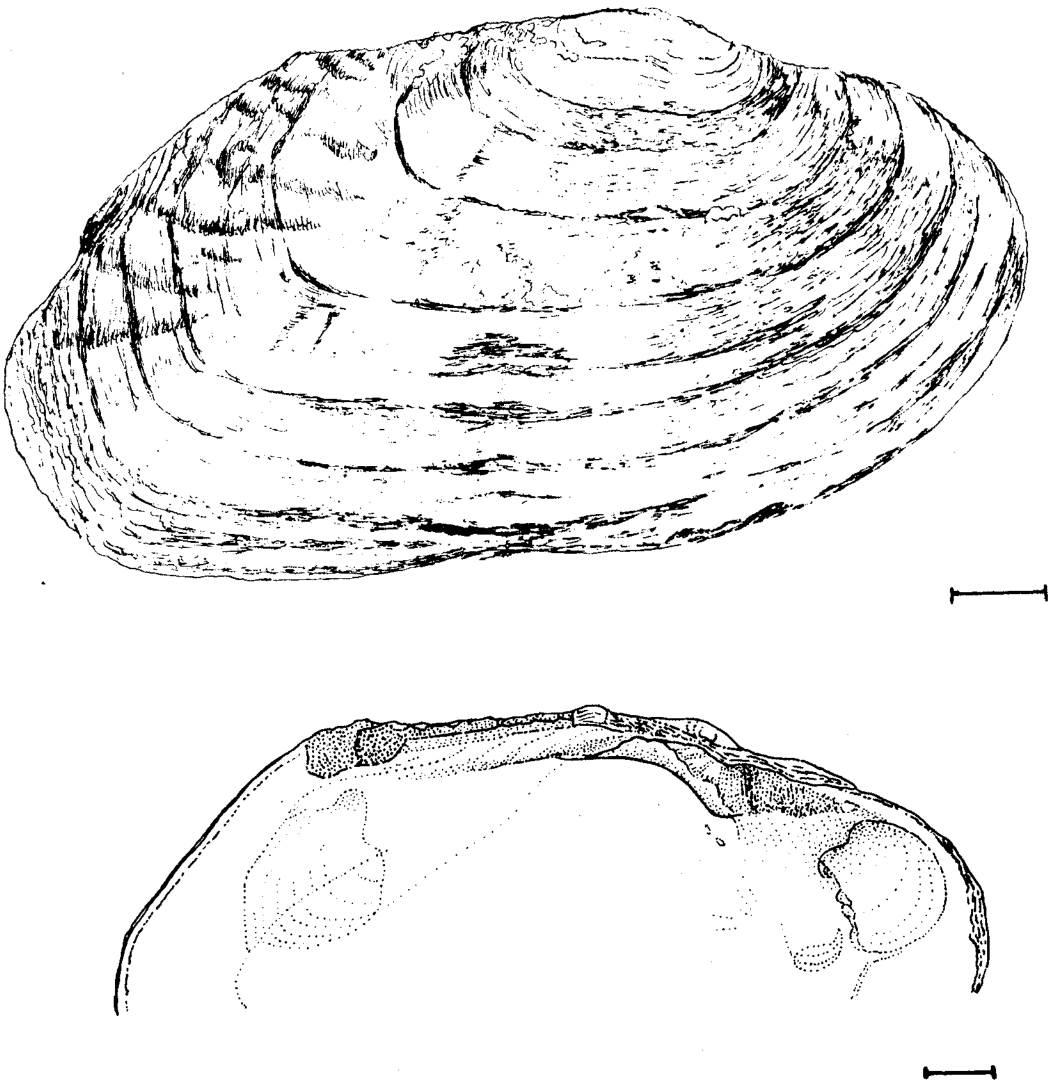


Fig. 35. *Lasmigona costata* - **right valve and hinge plate of left valve. Scale line = 1 cm.**

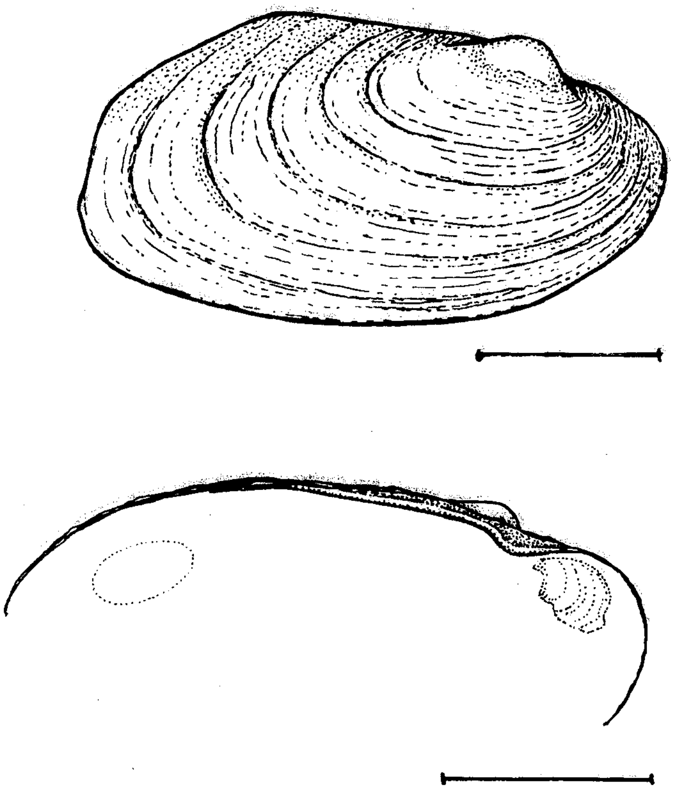


Fig. 36. *Simpsonaias ambigua* - right valve and hinge plate of left valve. Scale line = 1 cm.

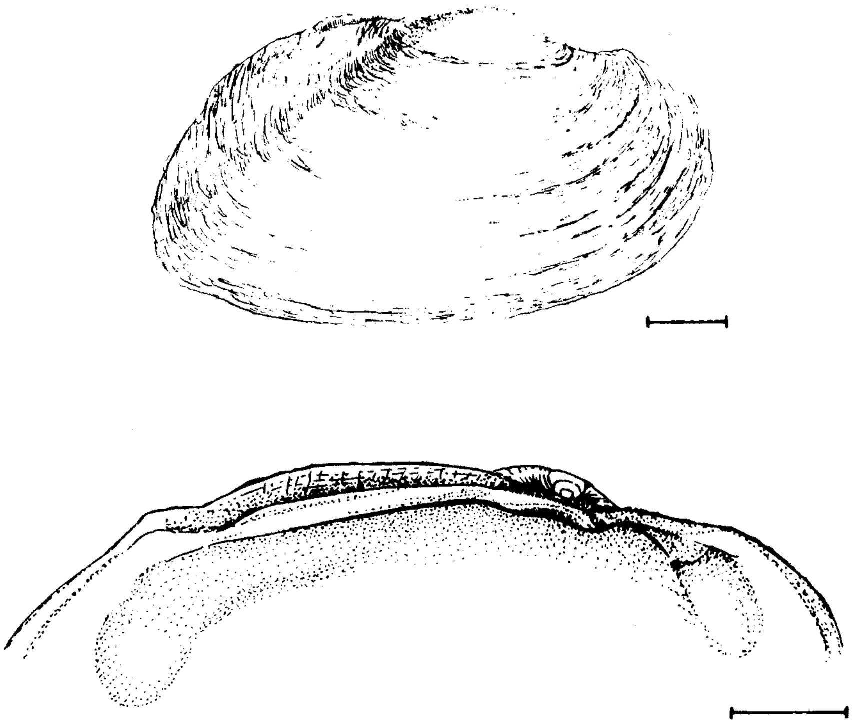


Fig. 37. *Strophitus undulatus* - right valve and hinge plate of left valve. Scale line = 1 cm.

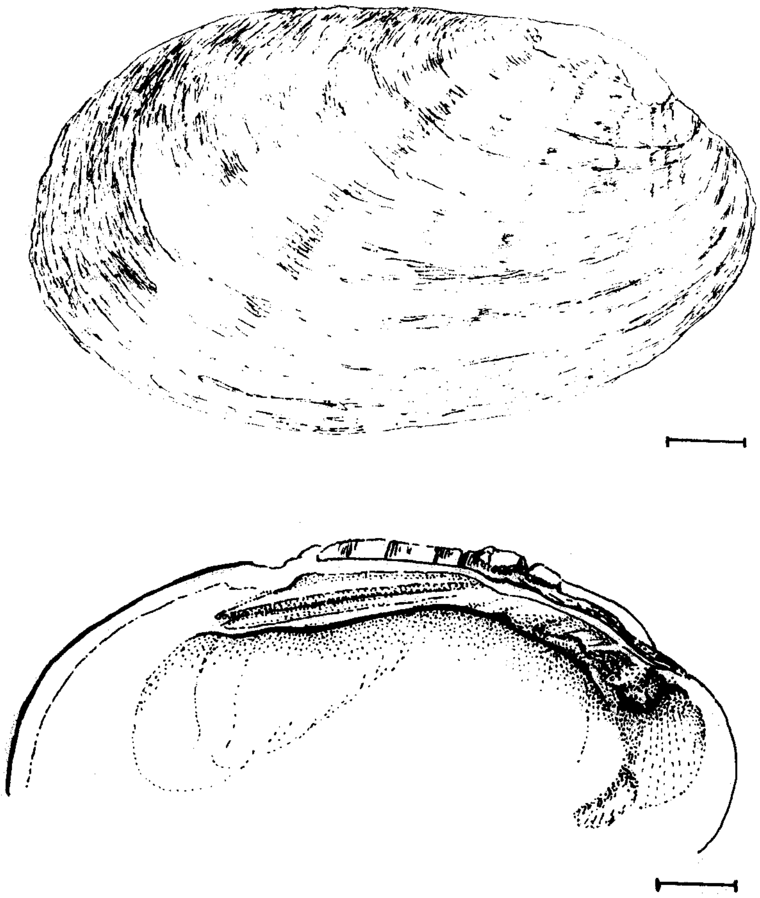


Fig. 38. *Actinonaias ligamentina* - right valve and hinge plate of left valve. Scale line = 1 cm.

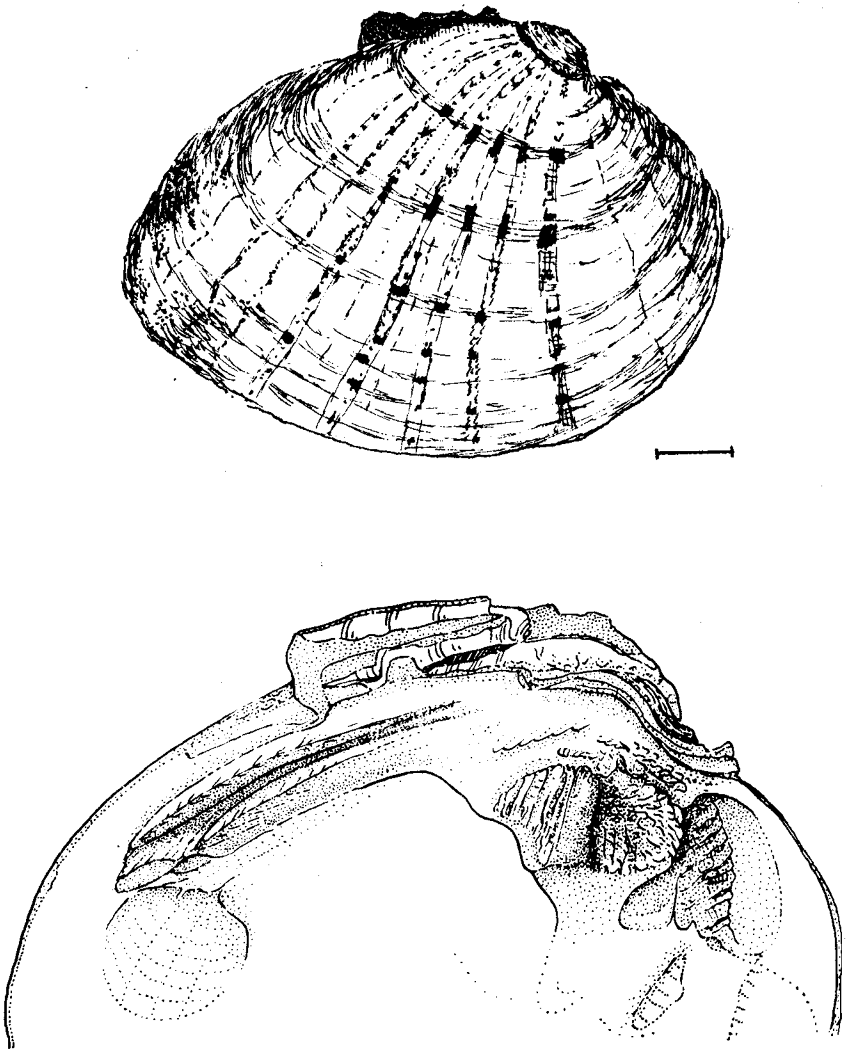


Fig. 39. *Ellipsaria lineolata* - right valve and hinge plate of left valve. Scale line = 1 cm.

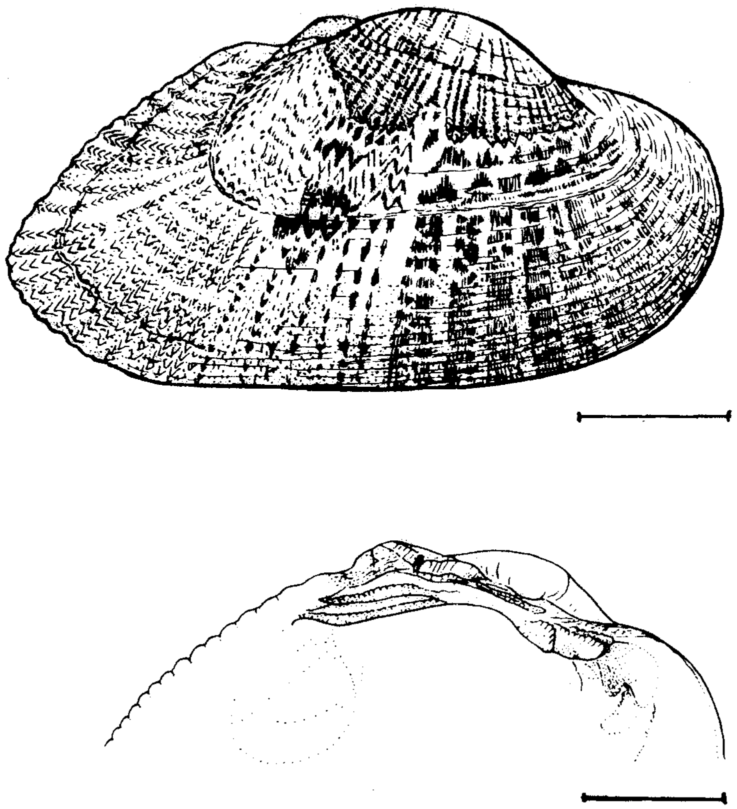


Fig. 40. *Epioblasma triquetra* - right valve and hinge plate of left valve. Scale line = 1 cm.

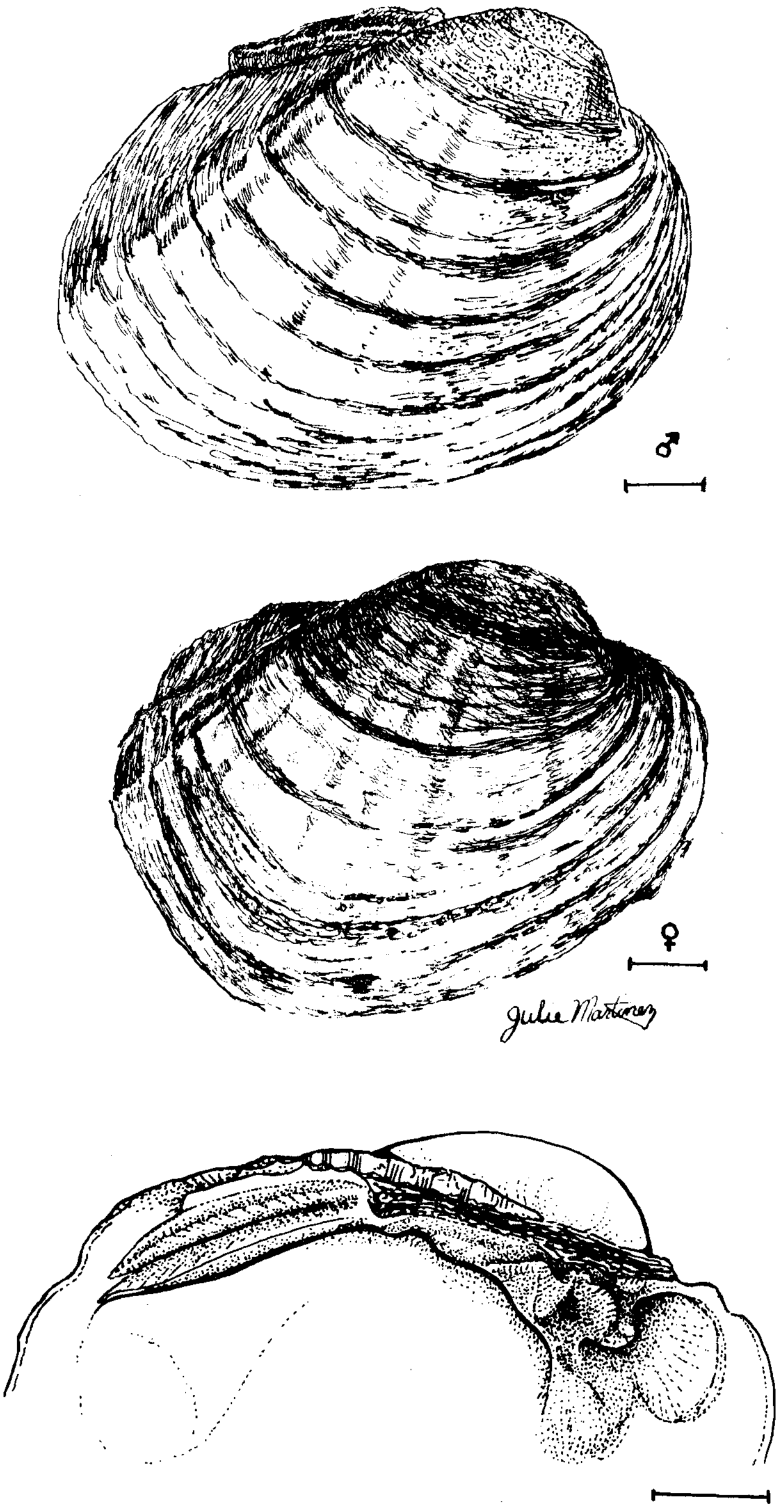


Fig. 41. *Lampsilis higginsi* - right valve of male (top), female (middle), and hinge plate of left valve.
Scale line = 1 cm.

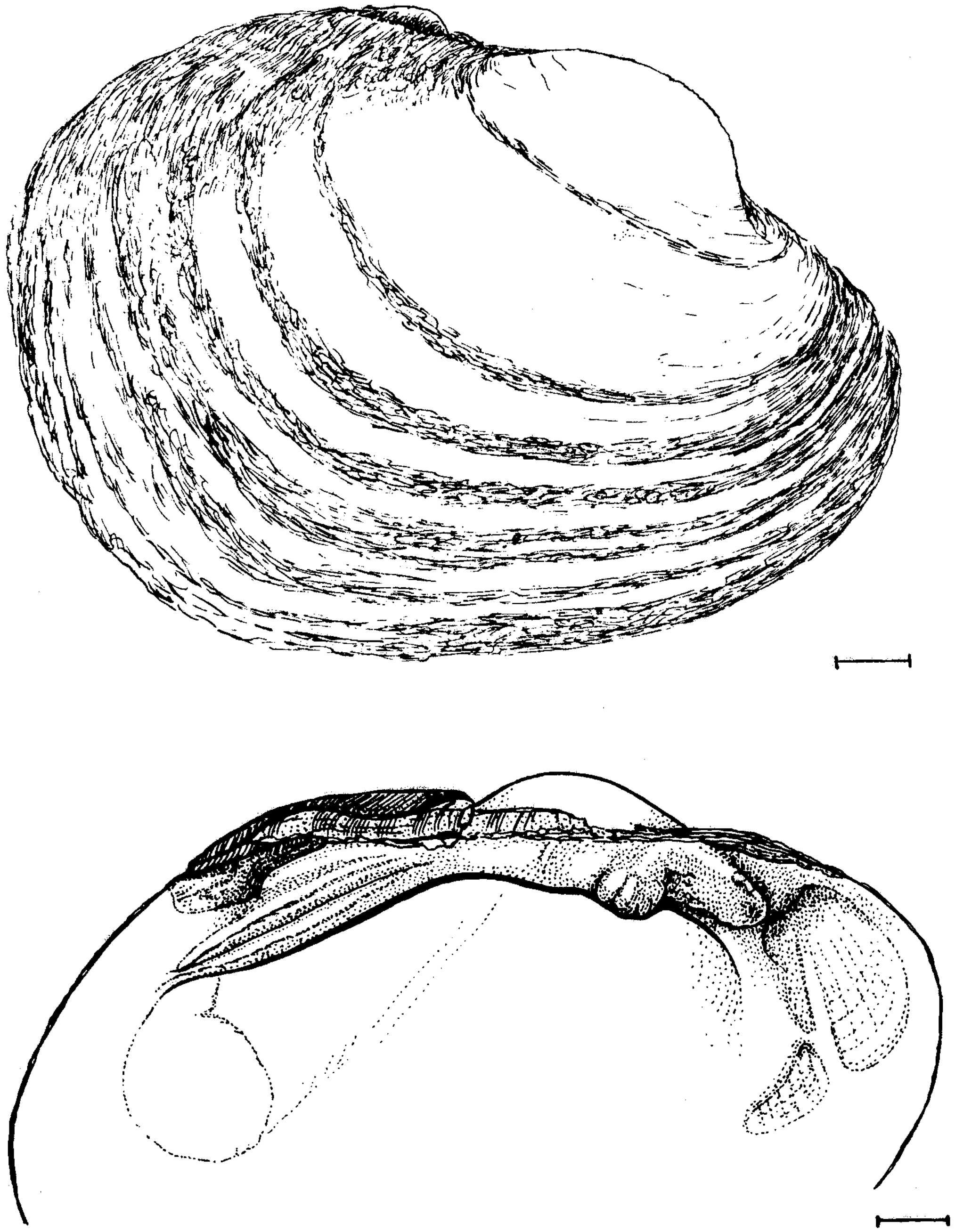


Fig. 42. *Lampsilis ovata* - right valve and hinge plate of left valve. Scale line = 1 cm.

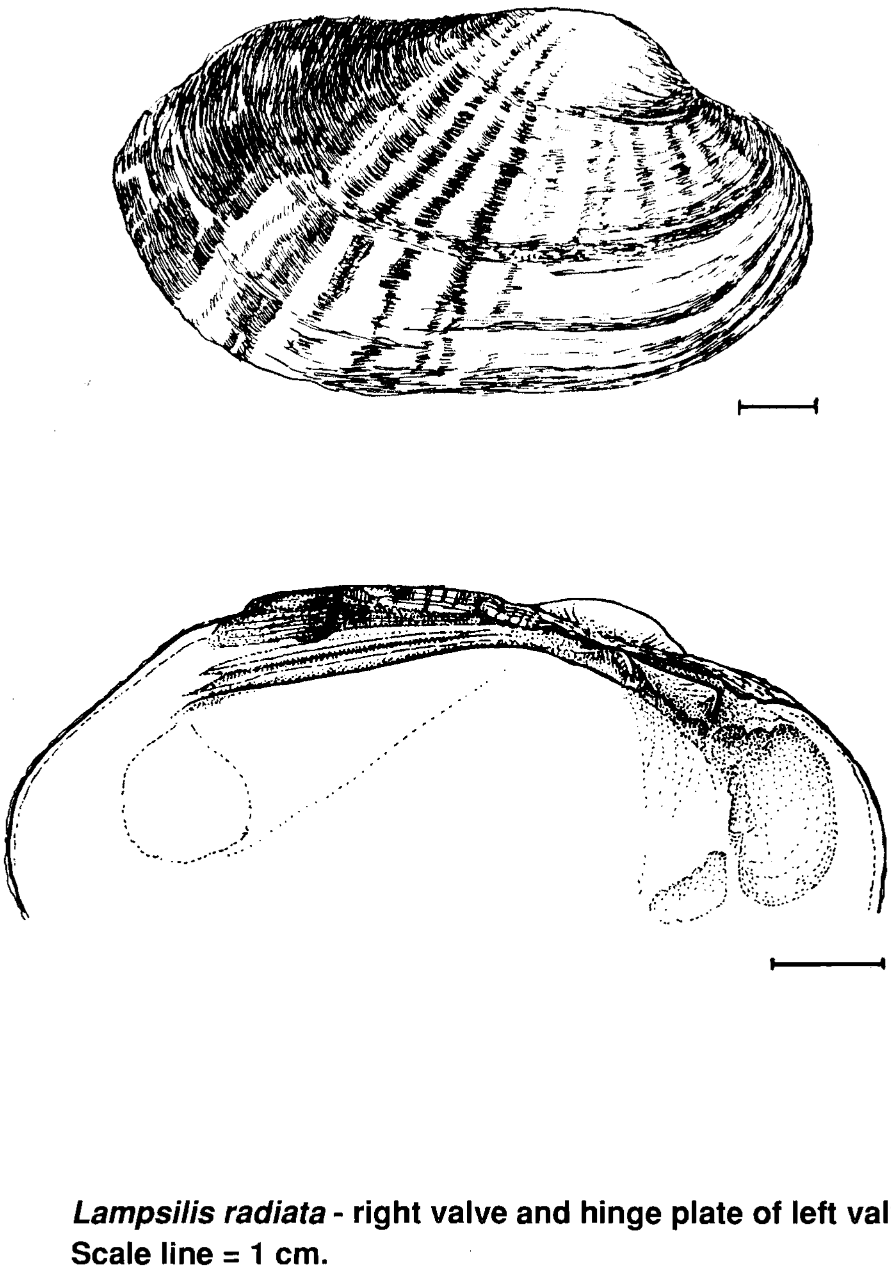


Fig. 43. *Lampsilis radiata* - right valve and hinge plate of left valve. Scale line = 1 cm.

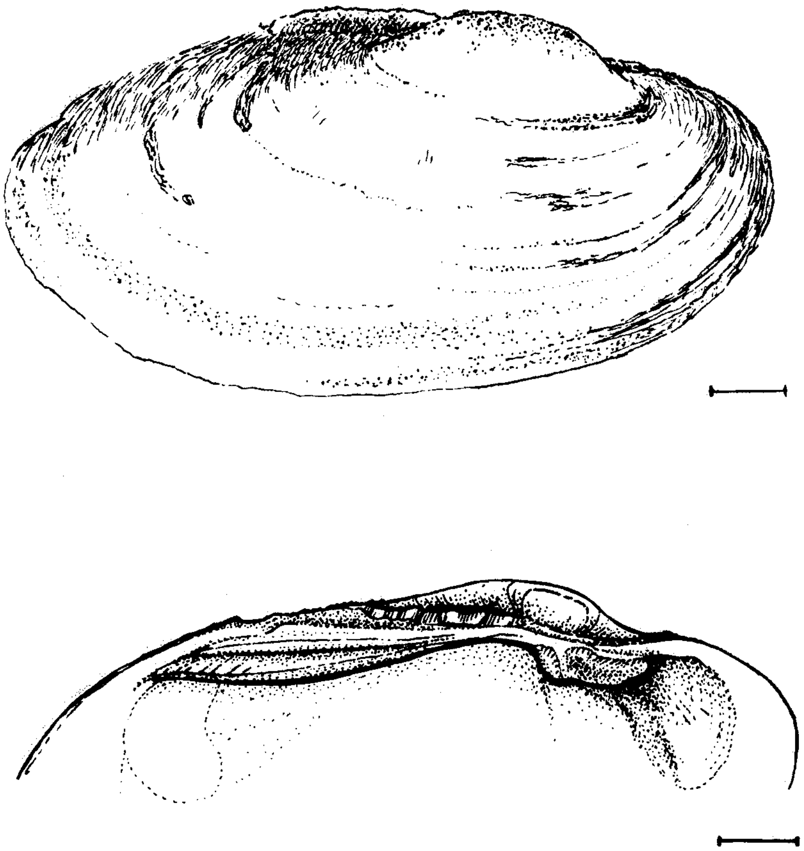


Fig. 44. *Lampsilis teres* - right valve and hinge plate of left valve. Scale line = 1 cm.

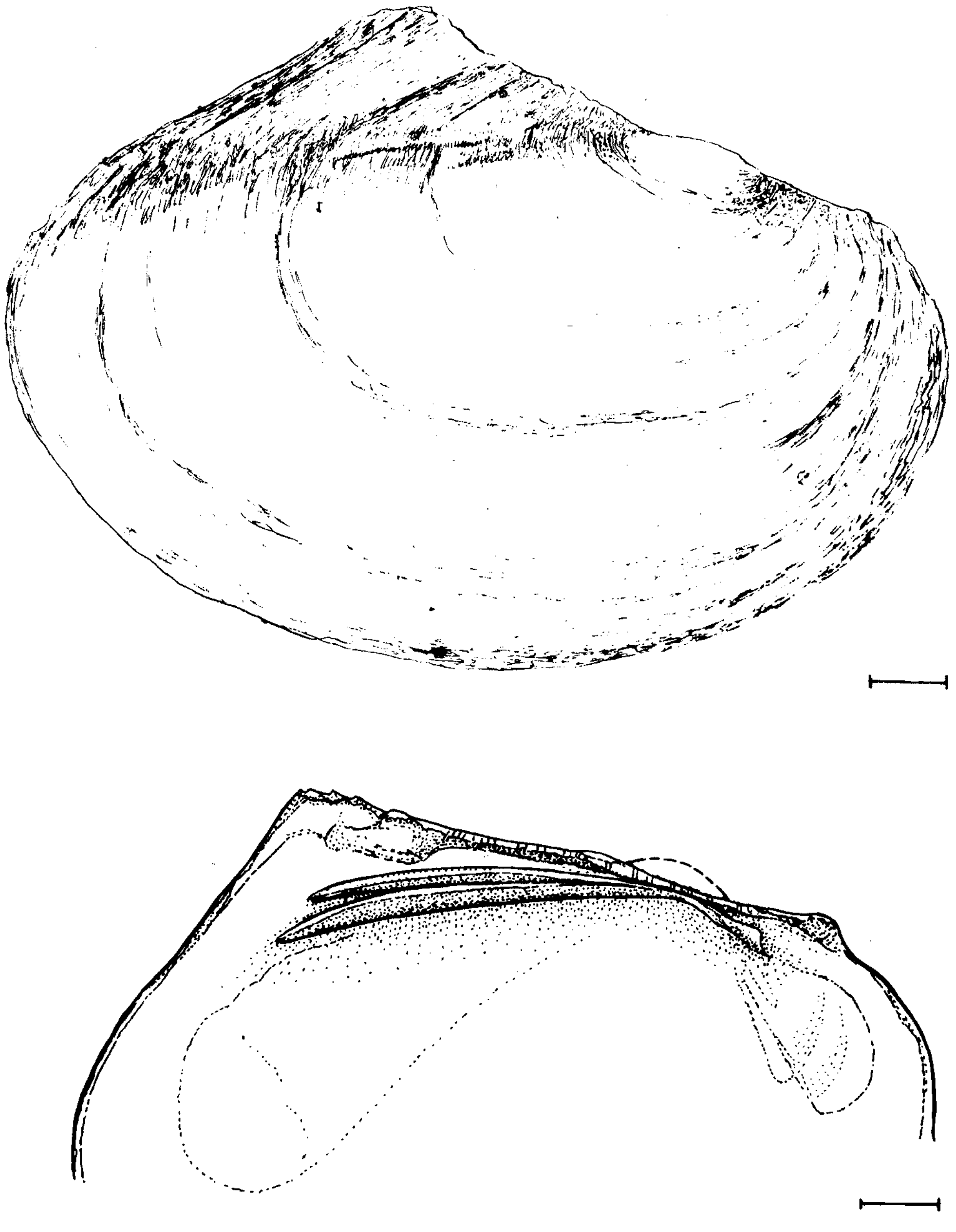


Fig. 45. *Leptodea fragilis* - **right valve and hinge plate of left valve. Scale line = 1 cm.**

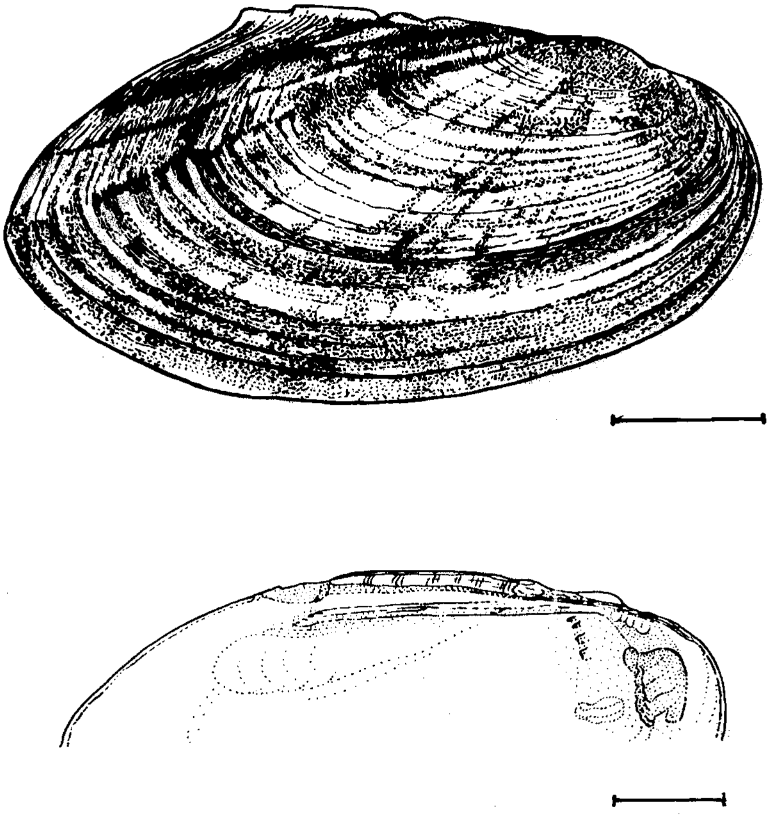


Fig. 46. *Leptodea leptodon* - right valve and hinge plate of left valve. Scale line = 1 cm.

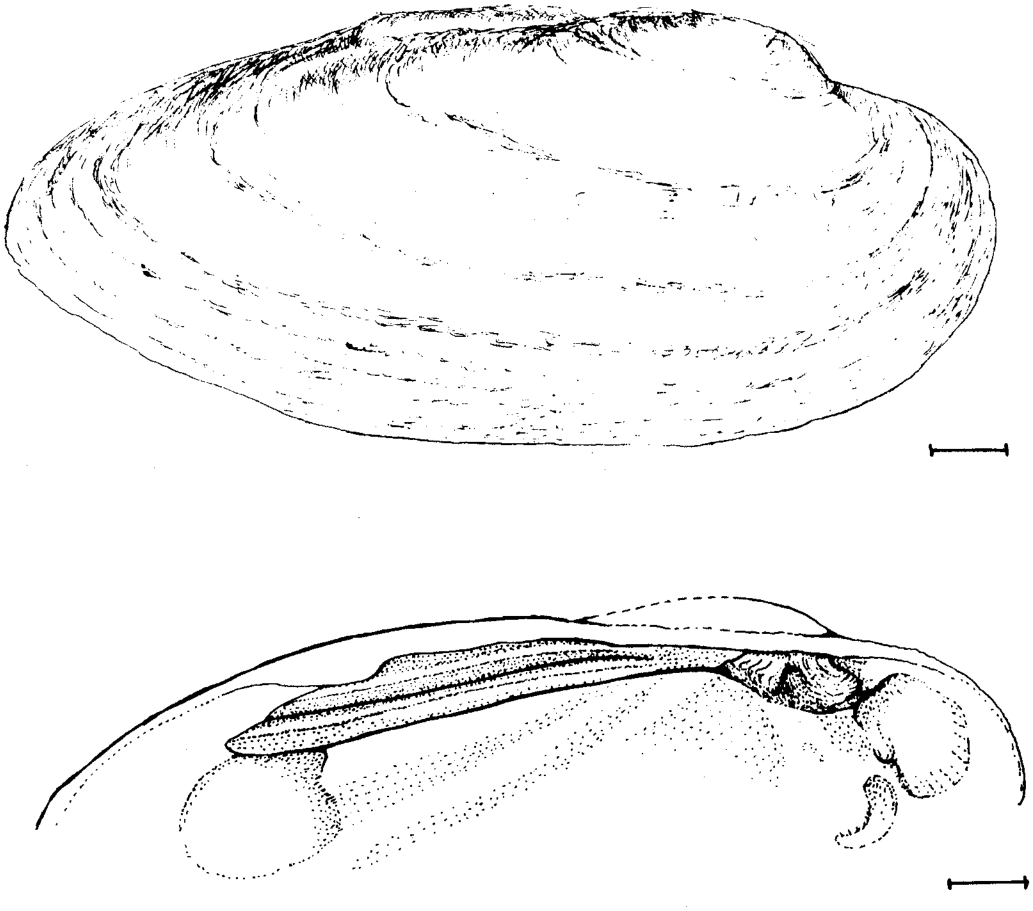


Fig. 47. *Ligumia recta* - right valve and hinge plate of left valve. Scale line = 1 cm.

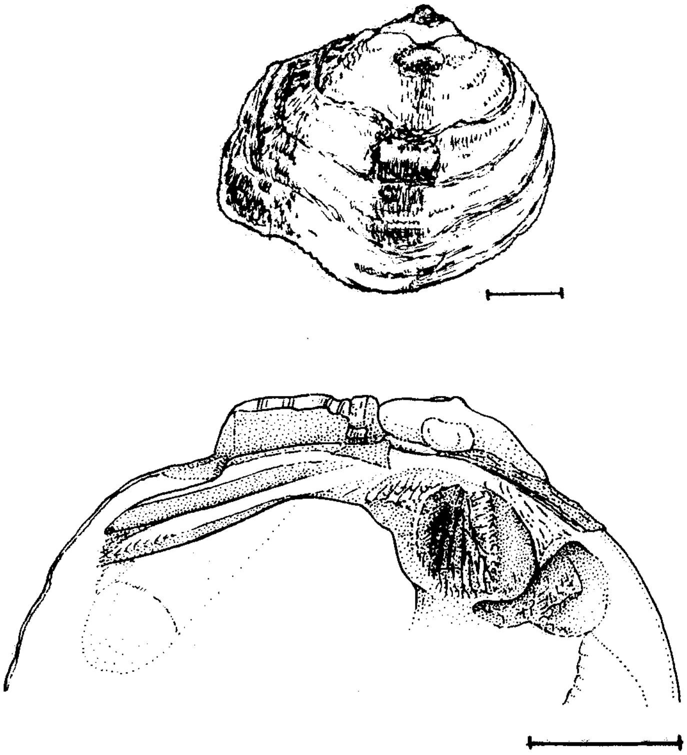


Fig. 48. *Obliquaria reflexa* - right valve and hinge plate of left valve. Scale line = 1 cm.

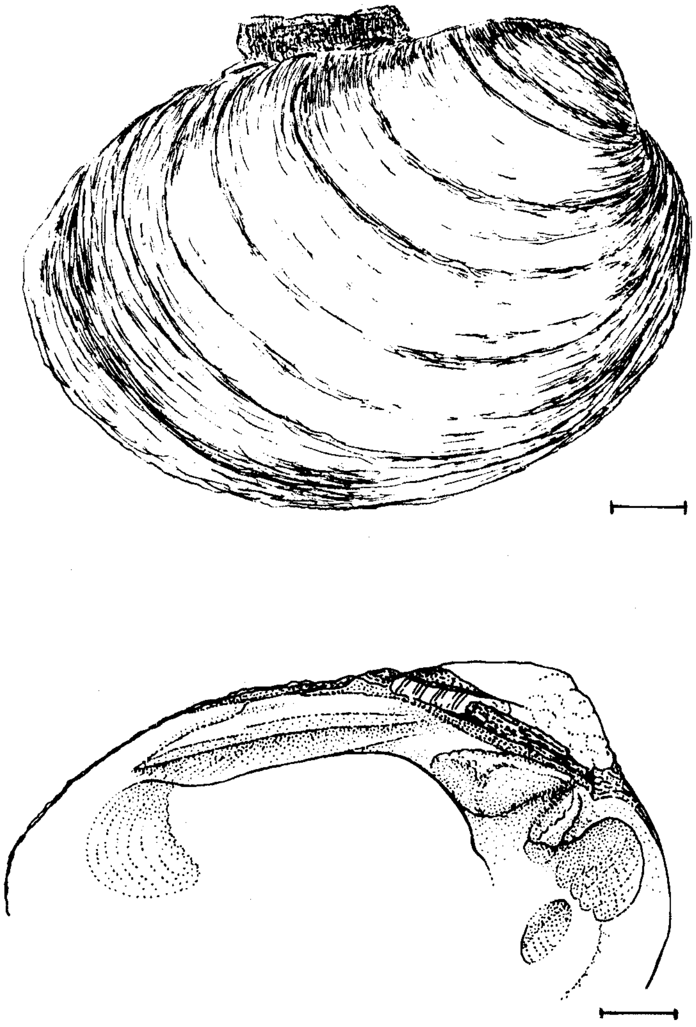


Fig. 49. *Obovaria olivaria* - right valve and hinge plate of left valve. Scale line = 1 cm.

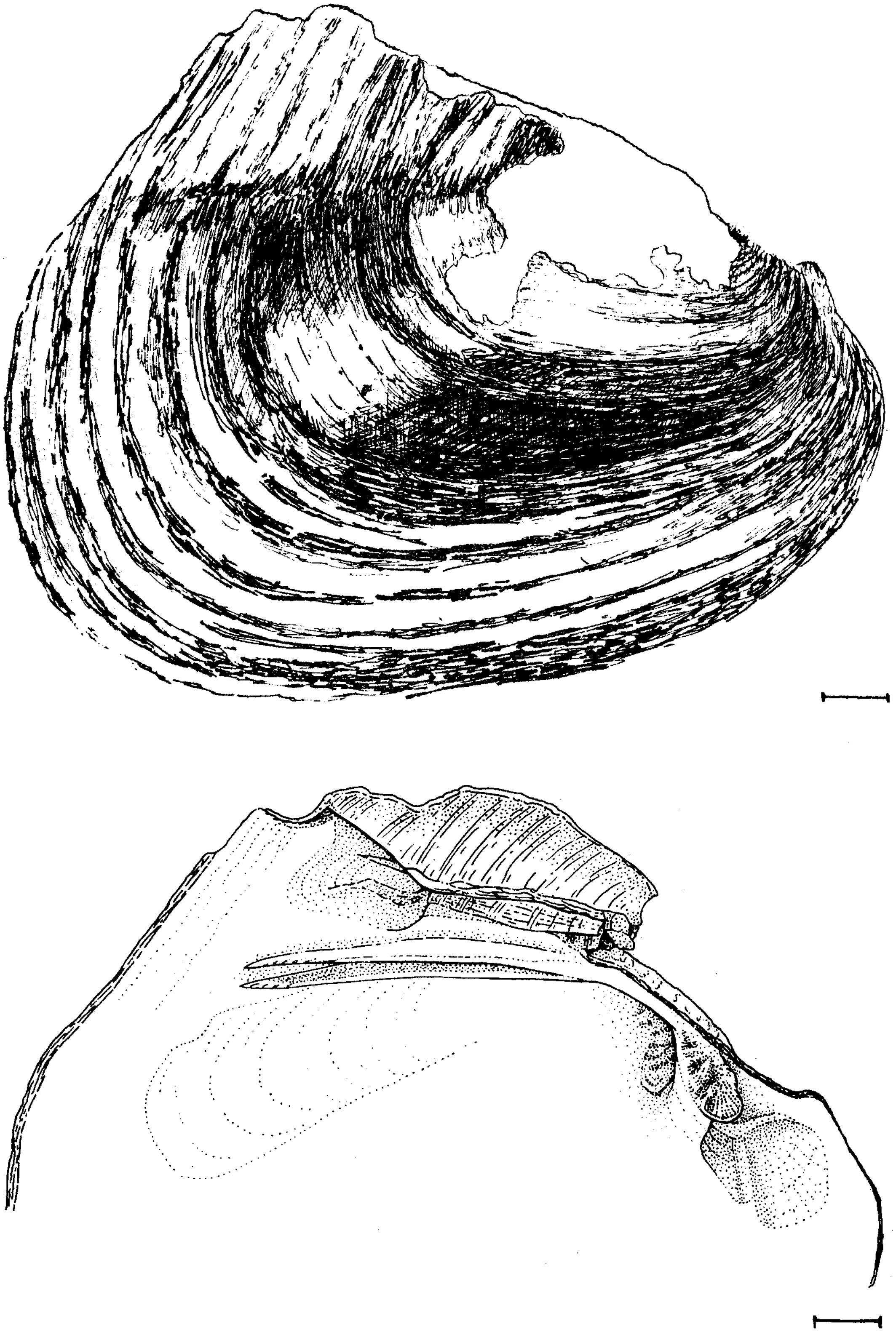


Fig. 50. *Potamilus alatus* - right valve and hinge plate of left valve. Scale line = 1 cm.

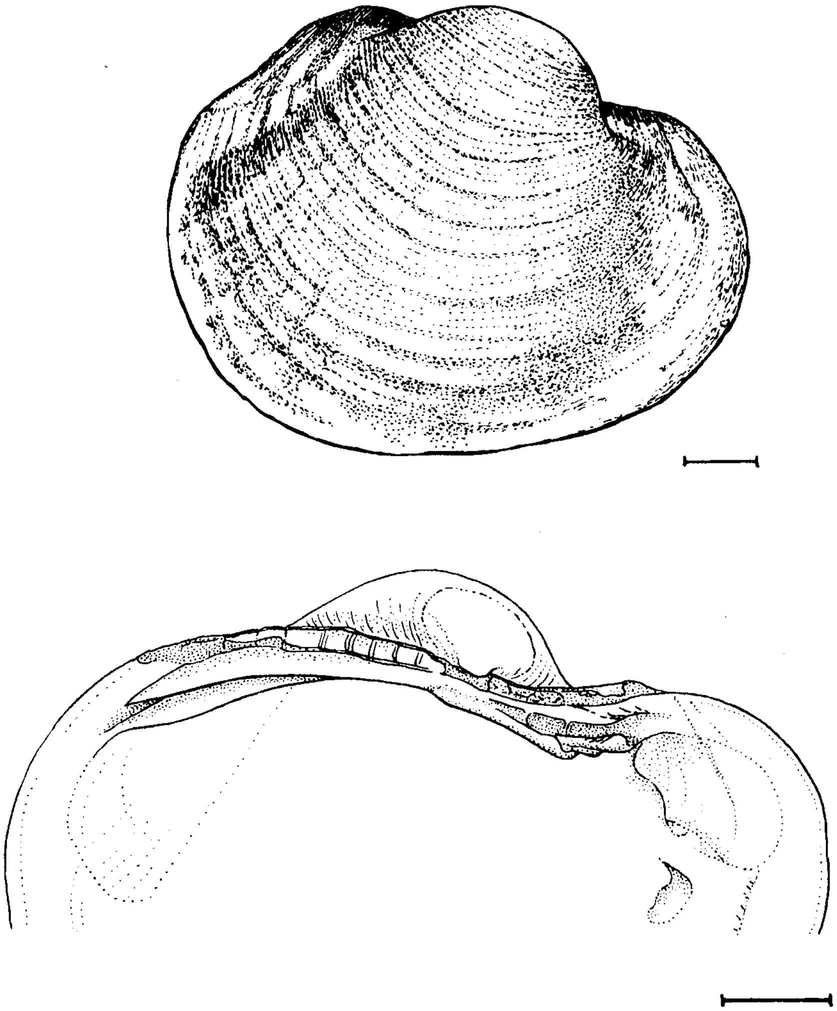


Fig. 51. *Potamilus capax* - right valve and hinge plate of left valve. Scale line = 1 cm.

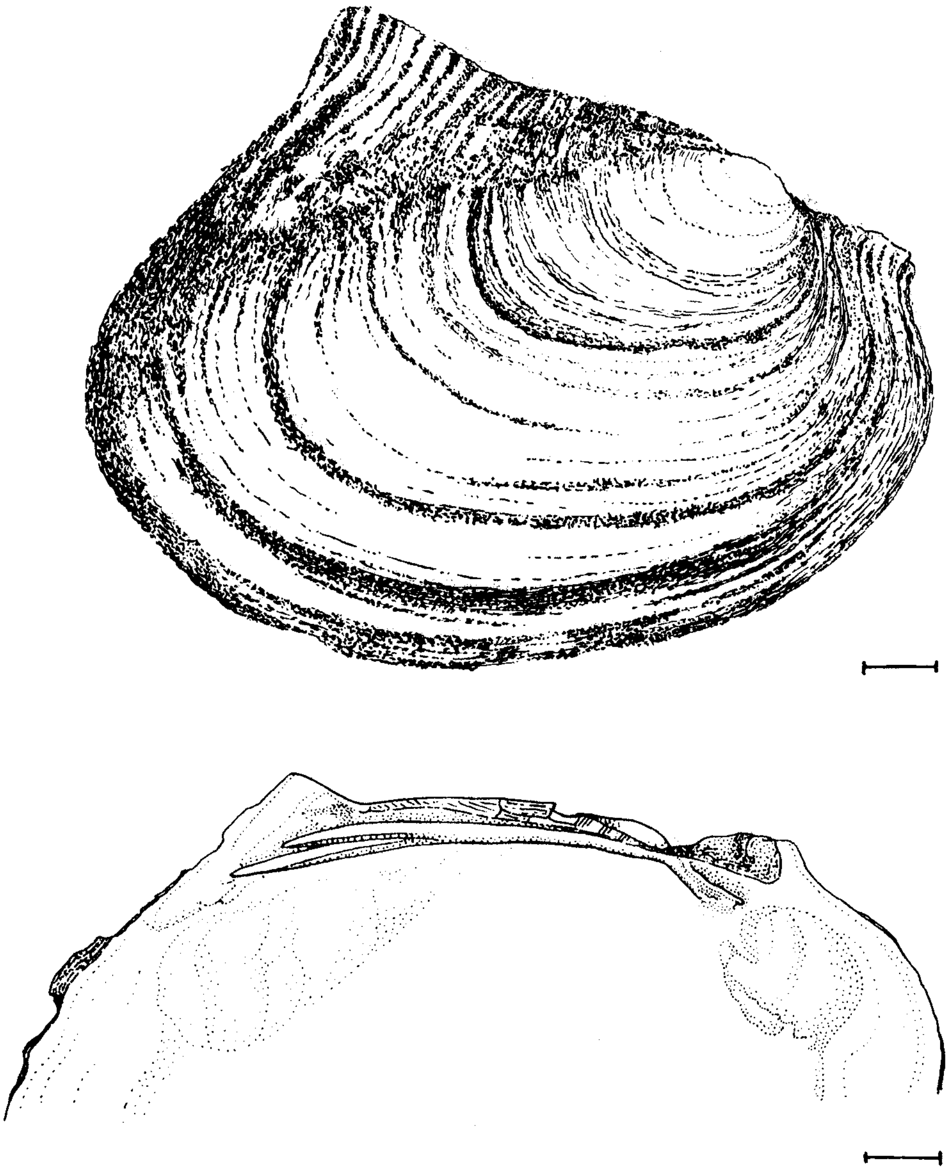


Fig. 52. *Potamilus ohiensis* - right valve and hinge plate of left valve. Scale line = 1 cm.

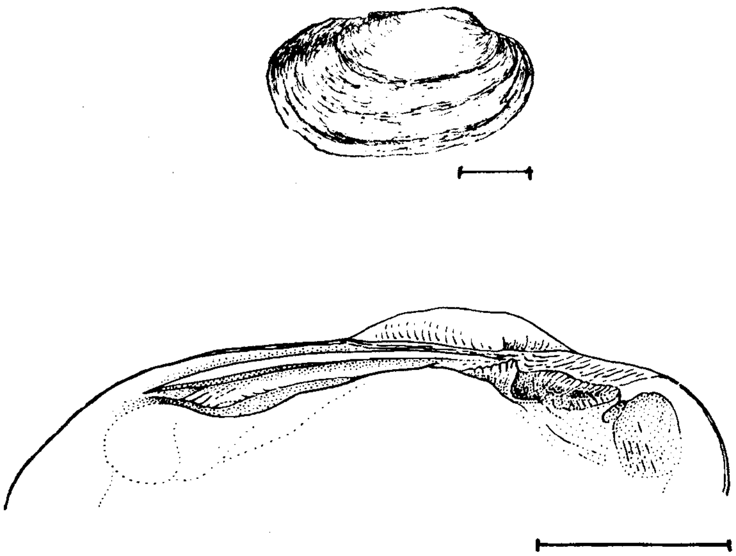


Fig. 53. *Toxolasma parvus* - right valve and hinge plate of left valve. Scale line = 1 cm.

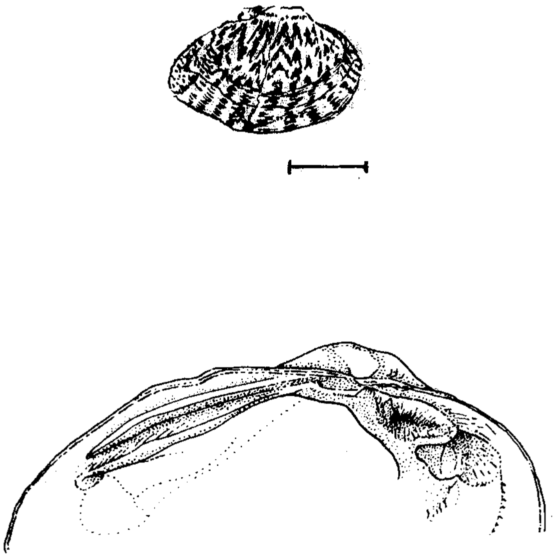


Fig. 54. *Truncilla donaciformis* - right valve and hinge plate of left valve. Scale line = 1 cm.

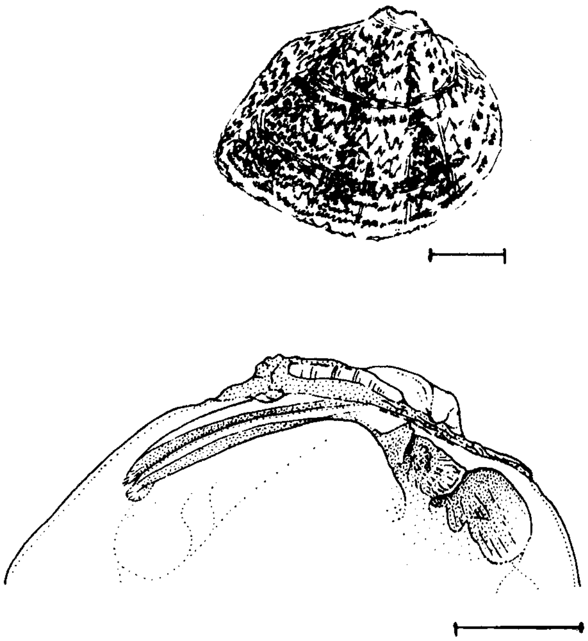


Fig. 55. *Truncilla truncata* - right valve and hinge plate of left valve. Scale line = 1 cm.

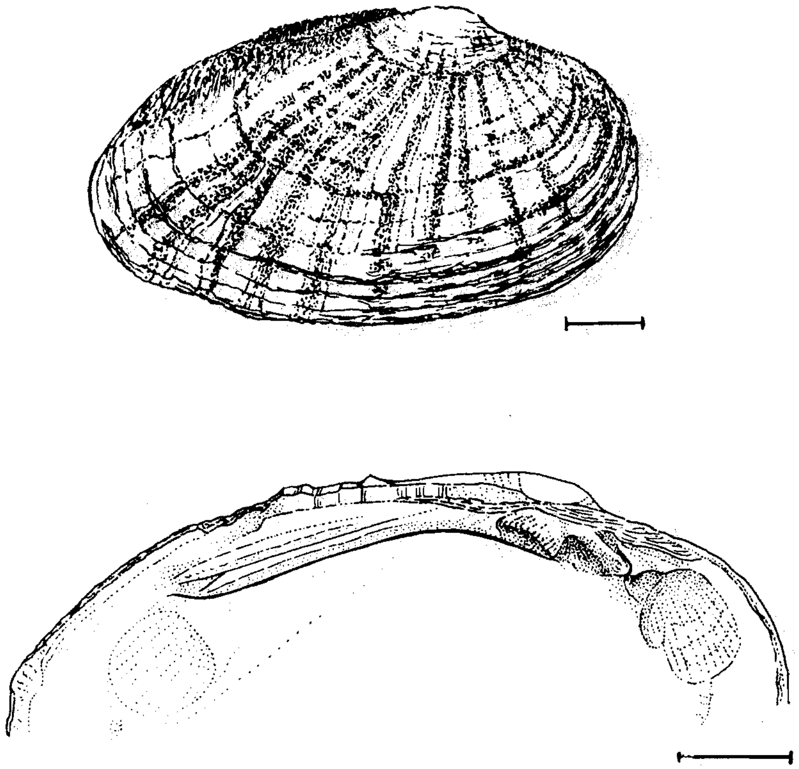


Fig. 56. *Venustaconcha ellipsiformis* - right valve and hinge plate of left valve. Scale line = 1 cm.

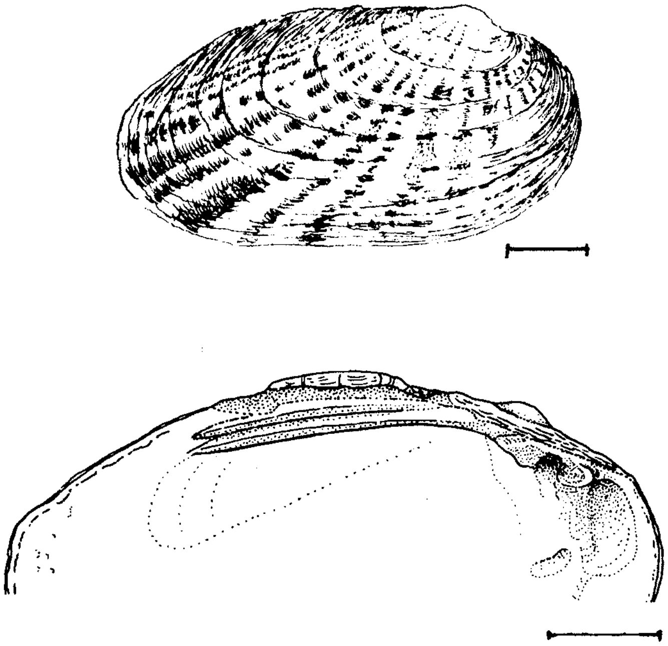


Fig. 57. *Villosa iris* - right valve and hinge plate of left valve.
Scale line = 1 cm.